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Control of Heavy-Duty Diesel NOx Emissions by Exhaust Gas Recirculation

Southwest Research Inst., San Antonio, TX

Prepared for

Environmental Protection Agency, Ann Arbor, MI

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Emission Control Technology Division
2565 Plymouth Road
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Contract No. 68-03-3162
Work Assignment 15

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Prepared for

ENVIRONMENTAL PROTECTION AGENCY
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FOREWORD

This report covers the effort under Work Assignment No. 15 of EPA Contract 68-03-3162, performed for the Emission Control Technology Division, Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, Michigan 48105. The EPA Contracting Officer was Mr. James M. Bzdusek, and the Project Officers were Mr. Robert J. Garbe and Mr. Craig A. Harvey. Mr. Robert Wagner was the EPA Branch Technical Representative. The Southwest Research Institute Project Leader was Sherrill F. Martin. Charles T. Hare, Project Manager, was involved in fiscal negotiations concerning this work assignment, and Charles M. Urban was involved in technical development of the test plan. The project was performed during April through August, 1984, and was identified as SwRI Project 03-7338-015.

ABSTRACT

A Cummins NTC-350 heavy-duty diesel engine was modified by the addition of a programmable EGR system. Tests were conducted using a computer to control the rate of EGR based on the instantaneous speed and torque condition of the engine during operation over the EPA transient cycle. The extent of NO_x reduction achievable with this system, along with corresponding effects on other emissions and fuel consumption, was explored.

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I. SUMMARY

A 1984 Cummins NTC-350 Big Cam 3 engine was used in this investigation of NO_x reduction by exhaust gas recirculation. Tests were conducted using a computer to control the rate of EGR based on the instantaneous speed and torque condition of the engine during operation over the EPA transient cycle. The extent of NO_x reduction achievable with this system, along with corresponding effects on other emissions and fuel consumption, was explored.

The baseline emissions values for the engine are given in Table 1, along with a selected summary of results using EGR. Peak torque for the baseline engine was 1185 lb-ft at 1250 rpm, and peak power was 340 hp at 2100 rpm. Tests were initially conducted with several fixed-size EGR systems, tests 4 through 7. Reductions in NO_x emissions were accompanied by increases in particulates.

TABLE 1. TRANSIENT EMISSIONS SUMMARY (HOT-STARTS)

Test	EGR Tube Description	Emissions, g/hp-hr HC	CO	NO_x	Part.	BSFC, lb/hp-hr
2,3	No EGR, Baseline, avg.	0.9	3.2	6.7	0.4	0.39
4	½" pipe from exhaust man.	0.9	6.9	4.1	0.9	0.41
5	1" pipe after turbine	0.9	3.8	5.4	0.5	0.40
6	1½" pipe, 7/8" dia. restriction	0.7	4.8	4.3	0.7	0.40
7	1½" pipe, 1" dia. restriction	0.8	6.0	4.1	0.8	0.42
15,19	1½" pipe, no restriction, avg.	0.8	14.3	2.2	2.1	0.41
17	10% smoke, base timing	0.7	6.7	3.6	1.0	0.40
21	10% smoke, 3° retard	0.7	5.7	3.3	0.9	0.40

A modulated EGR system was then constructed, using a 1½ inch EGR pipe. Installed in the pipe was a butterfly valve driven by a servomotor. A computer, using speed and torque information, gave programmed control to the EGR

hardware. A computer program based on achieving 10% smoke over the engine operating map gave the results shown as test 17. Retarding the timing 3 degrees and remapping the engine for 10% smoke gave the results of test 21. Both of these tests were near the specifications for passing the Federal smoke test (Table 2).

TABLE 2. SMOKE TEST SUMMARY, 10% SMOKE PROGRAM

Test No.	"Factor," Percent Opacity		
	A	B	C
17	17.3	13.4	27.5
21	22.2	10.2	32.3
Federal Limits	20	15	50

The percent EGR applied ranged from 23% at idle (wide open valve) to 8% at peak torque and 13% at peak power for base timing. For 3° retarded timing, the EGR was 5% at peak torque and 13% at peak power.

With the engine evaluated, about 50% reduction in NO_x was achieved using the EGR control schemes applied to it in this work assignment. Furthermore, a very useful investigative tool has been developed in the computer-controlled EGR system used to achieve these reductions.

II. RECOMMENDATIONS

The Scope of Work for this work assignment was limited to an exploratory evaluation of NO_x reduction using exhaust gas recirculation. For convenience in demonstrating "proof-of-principle," speed and torque of the engine were used as the control parameters.

NO_x reduction was determined to be sensitive to refinements in the control equations. Retarded timing appeared to provide a better NO_x - particulate balance than the stock timing. A useful tool has been developed in the computer-servo system employed in this work assignment. With it, additional optimization, including the benefits of retarded timing combined with EGR, could be conducted.

Other control parameters will be required for application of a controllable EGR system to a vehicle. These parameters could include exhaust temperature, exhaust backpressure, fuel rail pressure, and boost pressure from the turbocharger. Preliminary evaluation of potentially applicable parameters would enable further programming of the test stand computer to more closely simulate an on-board, over the road, computer-controlled EGR system.

III. INTRODUCTION

On March 26, 1984, Work Assignment No. 15, entitled "Control of Heavy-Duty Diesel NO_x Emissions," was authorized by the EPA Contracting Officer for contract 68-03-3162. The objectives of this work assignment were to determine baseline emissions of a heavy-duty diesel test engine, design and apply an EGR system for it, and perform evaluations of the minimum NO_x emissions achievable using exhaust gas recirculation. The system and methods used in conducting this work assignment were designed primarily to demonstrate "proof-of-principle," and are not directly applicable to production engines without further refinement.

IV. TEST PLAN, FACILITIES, AND ENGINE

This section describes the test plan, facility, and engine used in this work assignment.

A. Test Plan

The test plan was divided into three major parts. They are described in the following three sections.

1. Task 15.A. - Engine Baseline Testing

   a. Purchase a heavy-duty Diesel engine in the 300 to 400 horsepower range. The engine shall be a four-stroke cycle, turbocharged, aftercooled, direct-injection engine.
   b. Mount the engine on the test stand capable of performing the EPA transient test procedure.
   c. Perform duplicate tests over the EPA transient test procedure, including particulate emissions.
   d. Perform duplicate steady-state tests which include the following conditions:

Speed	Load, %
Idle	0
Rated	25, 50, 75, 100
Max. Torque	25, 50, 75, 100

2. Task 15.B - Design or Procurement of an Exhaust Gas Recirculation System

   Design and build, or procure an EGR system capable of automatically providing an EGR rate proportional to engine load and/or other parameters.

3. Task 15.C - EGR System Evaluation

   Conduct a series of optimization evaluations for minimum NO_x based on performance over the EPA transient test procedure. Optimization will be limited to EGR rate and injection timing, with primary emphasis on EGR rate.

B. Facilities

The facility used in fulfilling this work assignment was Test Cell No. 4 at the Emissions Research Laboratory, SwRI. This test cell is fully qualified for certification of engines by the EPA transient Federal test procedure. Additional instrumentation was installed to allow continuous measurement and recording of dilute and raw gaseous emissions, as well as smoke, particulate, and intake CO_2.

Engine control functions are managed by a CompuDAS data acquisition and control system. It is programmable in extended BASIC, and has unused analog inputs and outputs ideally suited to simulating a control system such as needed in this work.

C. Engine and Fuel

The engine selected for this program was a 1984 Cummins NTC-350 "Big Cam 3." It was purchased from the local Cummins sales and service organization for use in the project. The engine was selected because it is one of the most popular, therefore typical, engines in the 300 to 400 horsepower range. The manufacturer's specification for the engine are shown in Table 3. The oil used was Shell Rotella T-15W/40. Intake and exhaust restrictions at rated power were set for 20 inches of water and 2 inches of mercury, respectively, throughout the tests. Figure 1 is a view of the engine as mounted for testing.

TABLE 3. MANUFACTURER'S DATA, CUMMINS NTC-350 "BIG CAM 3"

Model	350 NTC
CPL	0632
Engine No.	11155547
Serial No.	24173
Date of Manufacture	2/84
CID	855
Rated Power	350 hp @ 2100 rpm
Idle Speed	575-650 rpm

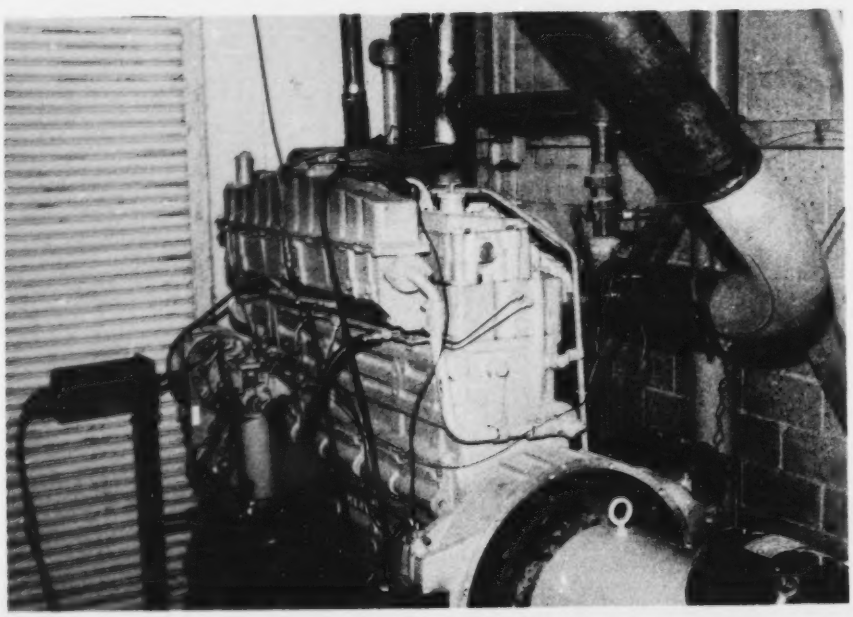

Figure 1. Cummins NTC-350 mounted for testing

The test fuel used in this program was a D-2 emissions compliance fuel obtained from Phillips Chemical Co., and coded by SwRI as EM-597-F. This fuel has become widely used by many manufacturers as well as by the EPA. Pertinent fuel properties determined by Phillips Chemical Co. are given in Figure 2, along with EPA specifications for emissions test fuel.

Laboratory Test Report

PHILLIPS CHEMICAL COMPANY
A SUBSIDIARY OF PHILLIPS PETROLEUM COMPANY

BARTLESVILLE OKLAHOMA 74004

DATE OF SHIPMENT 4-12-84
CUSTOMER ORDER NO. 33044
INV. OR REQN. NO. 00996S

EM-597-F
Diesel D-2 DCF
Lot No. G-075

Test	Results	EPA Specifications
Density, g/ml	0.8488	
API Gravity, 60 F	35.2	33 - 37
Sulfur, Wt%	0.35	0.2 - 0.5
Particulate Matter, mg/liter	2.07	
Pour Point, F	0	
Kinematic Viscosity, 40° C, CS	2.52	2.0 - 3.2
Flash Point, PM, F	162	130 Min.
Cloud Point, F	+12	
Distillation, D-86, °F		
IBP	375	340 - 400
5%	415	
10	431	400 - 460
20	451	
30	469	
40	487	
50	505	470 - 540
60	523	
70	543	
80	567	
90	598	550 - 610
95	628	
DP	648	
EP	653	580 - 660
Composition, Vol% by FIA		
Aromatics	32.10	27 Min.
Olefins	1.33	
Paraffins & Naphthenes	66.57	
Cetane Number	46.2	42 - 50
Elemental Analysis, wt, %		
Carbon	86.12	
Hydrogen	12.92	
Nitrogen	0.08	
Oxygen	0.06	
C/H	6.66	

Figure 2. Properties of Phillips D-2 diesel control fuel (SwRI EM-597-F)

V. INITIAL EVALUATIONS

This section describes the baseline testing and preliminary tests which led to the development of the final EGR system.

A. Baseline Testing

The engine was broken in for about seven hours at rated power before testing commenced. The baseline tests consisted of two EPA transient test sequences, and also three steady-state sequences which included the conditions specified in section I.d. of the test plan. These steady-state conditions constitute the major part of a 13-mode FTP. Since a computer program was already in existence for data reduction from a 13-mode test, this procedure was used whenever the steady-state conditions were needed. Results of the transient baseline are given in Table 4. All emissions were well within the Federal standards for 1984. NO_x, in particular, measured 61% of the 10.7 g/hp-hr limit. The hot results for NO_x track the combined values quite well, so use of the more cost effective hot-start tests for investigations and calibrations appeared to be appropriate.

TABLE 4. TRANSIENT BASELINE, CUMMINS NTC-350

Test	Emissions, g/hp-hr				BSFC, lb/hp-hr	Work, hp-hr
	HC	CO	NO_x	Part.		
2 C	1.20	2.93	5.83	0.49	0.41	24.40
2 H	0.95	3.31	6.79	0.42	0.39	24.14
Comb.	0.99	3.26	6.65	0.43	0.39	---
3 C	1.45	3.00	5.90	0.54	0.41	23.62
3 H	0.99	3.07	6.61	0.43	0.39	23.83
Comb.	1.06	3.06	6.51	0.45	0.40	---
Avg. Comb.	1.02	3.16	6.58	0.44	0.39	---
Avg. H	0.97	3.19	6.70	0.42	0.39	23.98

Modal NO_x data are shown in Table 5. Repeatability among the tests was quite good. The highest NO_x outputs occur at the higher torques, as would be expected, with the highest NO_x produced at peak torque speed.

TABLE 5. MODAL NO_x CONCENTRATIONS

Test No.	Idle	ppm NO_x at % Torque, Peak Torque Speed				% Torque, Rated Speed			
		25	50	75	100	25	50	75	100
1	85	515	1100	1675	2125	300	550	875	1212
2	82	510	1125	1625	2075	295	545	887	1212
3	72	460	1025	1562	1975	270	515	800	1175

For the baseline configuration, the peak torque was 1185 lb.-ft. at 1250 rpm. Peak power was 340 hp measured at 2100 rpm. This peak power is a 3% lower value than the manufacturer's rating shown in Table 3.

B. Preliminary EGR Evaluations

Initial sizing of the EGR pipe was determined through a series of experiments. On the premise that it would be desirable to have the system relatively insensitive to variations in intake and exhaust restrictions, a test was made with a ½ inch EGR line connected from the exhaust manifold to the air inlet upstream of the compressor. Results (test 4, Table 6) show that moderate NO_x reduction was achieved. HC was unaffected, CO more than doubled, and particulate doubled with this modification. Fuel consumption increased 5%, and peak torque decreased by 12%. This torque loss was considered too great, therefore the remaining sizing experiments, tests 5 through 7, took exhaust gas

TABLE 6. PRELIMINARY TRANSIENT TESTS, HOT-STARTS

Test No.	Emissions in g/hp hr				BSFC, lb/hp-hr	Peak Torque	Peak Power
	HC	CO	NO_x	Part.			
2,3	0.97	3.19	6.70	0.42	0.39	1185	340
4	0.87	6.90	4.11	0.88	0.41	1040	331
5	0.89	3.82	5.42	0.50	0.40	1146	345
6	0.72	4.78	4.34	0.66	0.40	1102	334
7	0.85	6.05	4.06	0.83	0.42	1076	336

downstream of the turbine. As the pipe size or restriction orifice increased in size, NO_x and peak torque decreased, while CO and particulate increased.

After this series of tests, the hardware to be used in the remainder of the project was constructed. A 1½ inch EGR line with a DC servo-controlled butterfly valve was the primary EGR control system. In anticipation that this might not provide enough flow at light load or idle, another modulated valve was installed in the exhaust pipe downstream of the EGR branch. This valve could then be used to increase the backpressure and force more EGR.

VI. PROGRAMMABLE EGR SYSTEM DEVELOPMENT AND EVALUATION

This section describes the hardware design of the EGR system, and the development of the computer control strategy. The final part of the section describes the results obtained using the system developed.

A. Programmable EGR System Design

Prior to the start of the assignment, four design approaches were considered as possibilities:

- direct control of the EGR orifice opening using a mechanical linkage from the engine throttle -- EGR rate would be a function of orifice opening and exhaust backpressure
- analog modulation of the EGR orifice opening, using a parameter such as exhaust gas temperature (possibly in conjunction with engine speed)
- programmed operation of the EGR system using the same computer which is used to operate the engine over the transient test cycle
- computer control of the EGR orifice opening using several measured engine operating parameters, such as speed, load, and exhaust temperature

The approach used was a combination of the third and fourth methods.

A modulated EGR system was constructed. It consisted of two butterfly valves, one in the 1½ inch EGR line, and one in the exhaust pipe after the EGR line. Both valves were actuated by Labeco servomotors with servo amplifiers. Position feedback was applied to the amplifiers so that voltage input from potentiometers or a computer resulted in reproducible positions of the control valves. The hardware is shown in Figure 3. A CompuDas computer was already installed in the test cell for the purpose of controlling the engine during transient operation. It was therefore available for controlling the two valves.

It only remained to decide which operating parameters to use as inputs, and how to translate them into control outputs. The parameters most readily available to the computer were speed and torque. These two parameters, at steady-state, specify any engine operating point. Other inputs could have been used, such as rail or boost pressure, rack position, or exhaust temperature. However, because this work assignment was only intended to demonstrate "proof-of-principle," speed and torque were chosen for convenience. Examining the test results from the preliminary EGR evaluations, it can be seen that the emissions which suffer from EGR application are CO and particulate. Smoke, when over the visibility threshold, is an easily measured surrogate for particulate. This led to the rule of thumb limit on maximum EGR rate, one limited by visible smoke. A limit to the amount of EGR which can be used is that which will still permit passing a Federal smoke test.

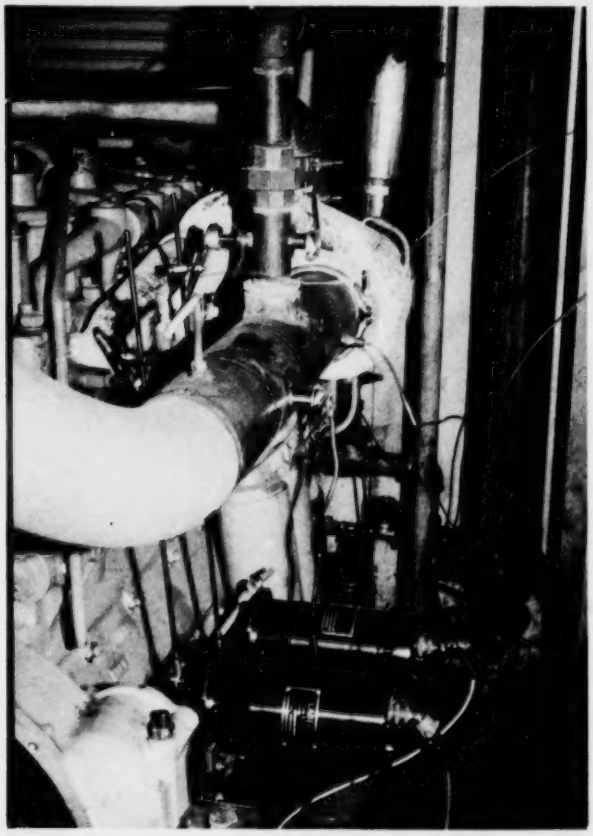

Figure 3. EGR hardware arrangement

B. EGR System Evaluation at Standard Injection Timing

With the premise that the limiting factor on the amount of EGR used should be the ability of the engine to pass a Federal Smoke Test, a guideline was arrived at for the maximum smoke to be permitted. It was decided that an approximation of 10% smoke at all steady-state operating points would be a reasonable level.

The EGR control valves were positioned by servomotors which incorporated position feedback for control by an analog circuit. The engine was mapped over the matrix of 2100, 1800, 1500, 1250, and 950 rpm and 100, 75, 50, and 25 percent torque. At each point in this matrix, the control voltage for 10 percent smoke was determined. All subsequent control schemes were based, in some fashion, on this mapping.

The first tests were run using a very simplified approximation for the control voltages. For each engine speed run in the 10% smoke map, the control voltages determined at 50%, 75%, and 100% torque were averaged. A second order (parabolic) equation of voltage versus speed was fitted to the resulting points. The resulting equation was

$$\text{Voltage} = -2.75 + 0.0884\,(\text{RPM}) - 0.000003035\,(\text{RPM})^2.$$

This equation was used anytime the command torque in the cycle was over 50%.

For command torques below 25% a straight line was fitted to the 25% torque points from the 10% smoke map. This equation was

Voltage = 1.01 +0.00044 (RPM).

For torque commands between 25% and 50%, linear interpolation between the results of these two equations was used.

Backpressure augmentation was not needed to achieve 10% smoke at loads over 50%. Therefore, at 50% or greater loads, the valve was fixed wide open, or at 4.05 volts. For torque commands of 25% or less, the voltages necessary for 10% smoke at 25% torque were used. A straight line was fitted to these data resulting in

Voltage = 0.63 + 0.00065 (RPM).

For torques between 25% and 50%, linear interpolation between the above operation and 4.05 volts (wide open valve) was used. Figures B-1 and B-2 in Appendix B show the control voltages used for the EGR valve and backpressure valve positioning, respectively. Test 8, Table 7, shows the results of this configuration. NO_x reduction was not as great as with the unmodulated 1½ inch pipe - 1 inch restriction of test 7, Table 6. Fuel consumption was noticeably

TABLE 7. TRANSIENT TEST SUMMARY, HOT-STARTS ONLY

Test No.	Emissions, g/hp-hr				BSFC, lb/hp-hr
	HC	CO	NO_x	Part.	
8	0.59	5.39	4.74	0.74	0.43
9	0.87	4.63	4.63	0.68	0.41
10	0.76	6.43	3.91	0.85	0.41
11	0.83	6.87	3.87	0.92	0.42
12	0.80	6.87	3.97	0.90	0.42
13	0.79	6.09	4.10	0.83	0.42
14	0.88	6.86	3.74	1.05	0.42
15	0.80	14.29	2.18	1.12	0.41
16	0.76	8.98	3.25	1.32	0.42
17	0.73	6.68	3.64	0.98	0.40

higher. On the assumption that the increased fuel consumption was caused by the increased backpressure, test 9 was run with the backpressure valve fixed open. The EGR valve was again controlled as in Figure B-1. NO_x decreased slightly, and fuel economy improved. All further testing was done with the modulated backpressure valve fixed open.

The next three tests, 10, 11, and 12, used an increased amount of EGR at torques over 25%. This was done by reducing the difference between the over

50% torque equation and the under 25% torque equation (see Figures B-3, -4, and -5.) For test 10 the equation for greater than 50% torque points was

$$\text{Voltage} = -0.87 + 0.00464\,(\text{RPM}) - 0.0000015175\,(\text{RPM})^2.$$

For test 11 the equation for greater than 50% torque points was

$$\text{Voltage} = 0.08 + 0.00254\,(\text{RPM}) - 0.000000759\,(\text{RPM})^2.$$

For test 12, the control voltage was not varied with load but was a function of speed only,

$$\text{Voltage} = 1.01 + 0.00044\,(\text{RPM}).$$

The graphs in Figures B-3, B-4, and B-5 illustrate the control voltage schemes. NO_x appeared to "bottom out" in this region of operation.

Test 13 used a straight-line relationship based on the 50% load - 10% smoke data. The line was forced to fit the data point at 2100 rpm with a best fit of the rest of the data. This control line is shown in Figure B-6. There was no modulation based on load. The equation was

$$\text{Voltage} = 4.72 - 0.00132\,(\text{RPM}).$$

In Table 8, bag-by-bag NO_x information is given. It is seen that test 10 had the lowest NO_x for bags 1, 2, and 4. Bag 3 consists principally of high-speed operation, while bags 1, 2, and 4 are weighted toward the lower end of the rpm range. Therefore a new equation was developed for torques of 50% and over which was equivalent to the test 10 equation at 2100 rpm and to the test 11 equations at 650 rpm:

$$\text{Voltage} = -1.28 + 0.00620\,(\text{RPM}) - 3.273 \times 10^{-6}\,(\text{RPM})^2 + 5.1425 \times 10^{-10}\,(\text{RPM})^3.$$

A plot of this equation is shown in Figure B-7.

TABLE 8. INDIVIDUAL BAG NO_x - TRANSIENT TESTS

Test No.	NO_x g/hp-hr Bag 1	Bag 2	Bag 3	Bag 4
8	4.41	4.61	4.84	4.86
9	4.69	4.56	4.70	5.13
10	3.84	3.92	3.86	4.17
11	3.74	3.69	3.96	3.93
12	3.90	3.96	3.96	4.10
13	4.29	3.92	3.99	4.63
14	3.52	3.53	3.80	4.00
15	1.94	1.96	2.25	2.41
16	3.12	3.08	3.32	3.36
17	3.34	3.34	3.71	4.15

Test 14 then showed the lowest NO_x yet, with new low values for all bags except bag 4. This result seemed to exhaust the possibilities of the rather simplified set of equations used to that date.

Run 15 was made with the EGR valve wide open for the duration of the test. The appealingly low value of NO_x, 2.18 g/hp-hr (combined), was countered by CO of 14.3 g/hp-hr and 80% smoke (Table 9) in the lugdown phase of a

TABLE 9. SMOKE TEST RESULTS

	"Factor," Percent Opacity		
Test No.	A	B	C
15	49.5	80.3	81.2
16	22.7	12.4	29.6
17	17.3	13.4	27.5
Federal Limits	20	15	50

Federal smoke test run with the same setting. For test 16, a more complete set of equations was used to modulate the EGR valve (no backpressure modulation). A second-order polynomial curve fit was performed for the control voltages at 100%, 75%, and 50% load. The valve was set completely open at 25% load or less, because this position produced 10% or lower smoke readings. The NO_x (dashed) line in Figure 4 shows that the NO_x produced at idle is negligible.

The time spent in the cycle between 0% and 25% torque is 152 seconds, or less than 13% of the total time. The NO_x contribution from this region of engine operation appears to be small, but future study of a system which could provide more EGR without too much backpressure may be worthwhile. The control voltages are shown in Figure B-8. The equations for the appropriate load lines are:

$$\text{Voltage}_{100} = 3.62 + 0.00029\,(\text{RPM}) - 2.51 \times 10^{-7}\,(\text{RPM})^2$$
$$\text{Voltage}_{75} = 2.31 + 0.001325\,(\text{RPM}) - 4.9 \times 10^{-7}\,(\text{RPM})^2$$
$$\text{Voltage}_{50} = 1.59 + 0.000678\,(\text{RPM}) - 1.642 \times 10^{-7}\,(\text{RPM})^2$$
$$\text{Voltage}_{25} = 2.11.$$

At any given speed the computer program would interpolate between the two nearest constant percent load polynomials to determine the command voltage at that instant. The butterfly valve position was updated at one second intervals throughout the cycle. Input was from the computer commands in order to give a slight lead to the valve positioning. Test 16 gave the lowest NO_x value yet with a modulated EGR valve. However, it was determined that the linkage to the EGR valve had been disconnected and re-connected prior to test 16. It was suspected that the adjustment was therefore changed. The 10% smoke mapping of the engine was repeated, which yielded a new set of second-

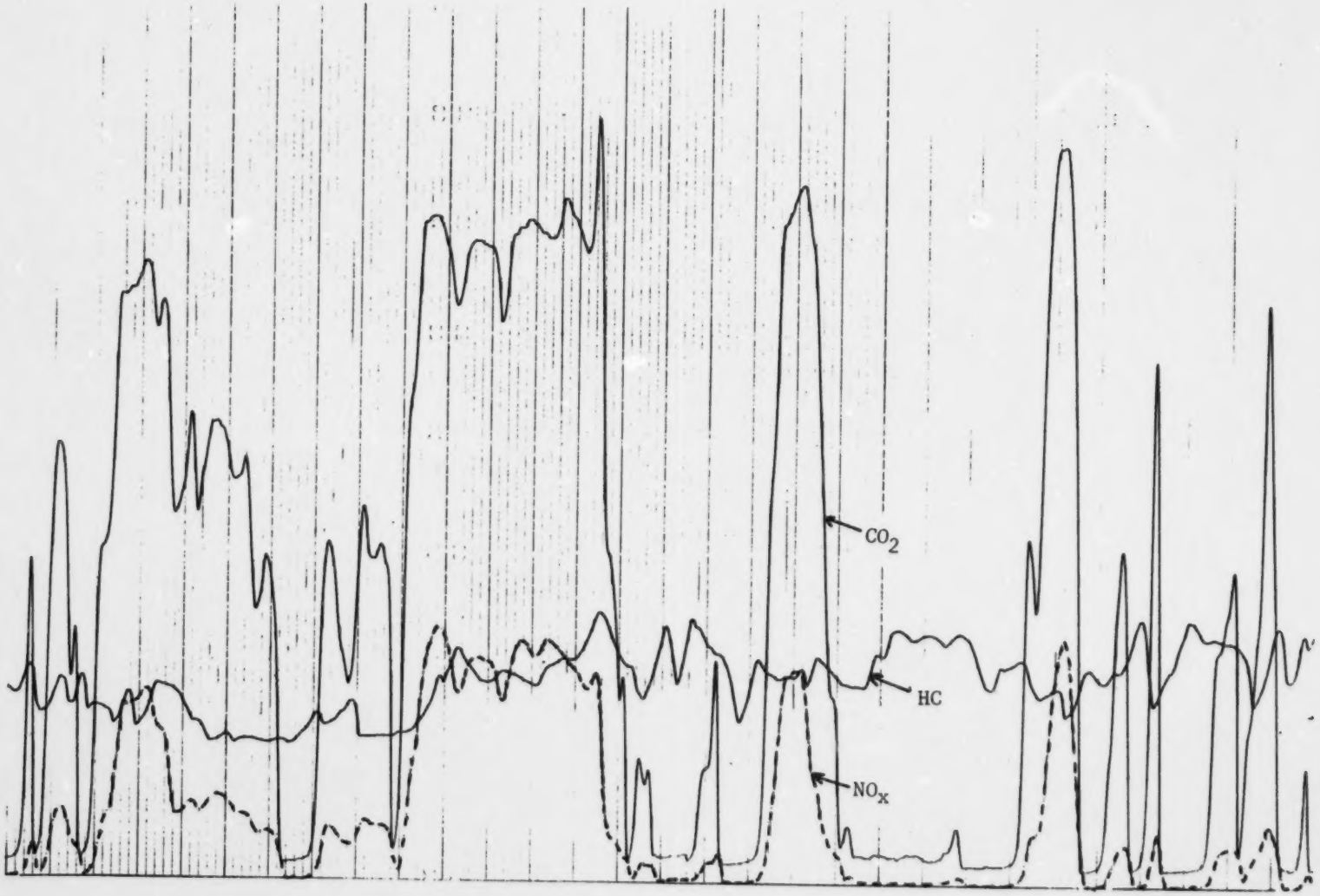

Figure 4. Sample emissions trace

order polynomials for the computer, Figure B-9. These equations are:

$$\text{Voltage}_{100} = 1.73 + 0.00344\,(\text{RPM}) - 1.365 \times 10^{-6}\,(\text{RPM})^2$$
$$\text{Voltage}_{75} = -1.64 + 0.00741\,(\text{RPM}) - 2.541 \times 10^{-6}\,(\text{RPM})^2$$
$$\text{Voltage}_{50} = 0\text{-}7.44 + 0.01435\,(\text{RPM}) - 4.701 \times 10^{-6}\,(\text{RPM})^2$$
$$\text{Voltage}_{25} = 0.03 + 0.001768\,(\text{RPM}) - 4.23 \times 10^{-7}\,(\text{RPM})^2.$$

Results of this mapping are shown as test 17, which included a cold start followed by two hot starts.

The next two tests run were intended to confirm the previous tests which had yielded the lowest NO_x values. Test 18 consisted of two hot-starts conducted with the same EGR equations as test 16. Table 10 shows data from both tests. Repeatability was quite good, except for BSFC.

TABLE 10. CONFIRMATION OF TEST 16 DATA

Test No.	Emissions, g/hp-hr				BSFC, lb/hp-hr
	HC	CO	NO_x	Part.	
16	0.76	8.98	3.25	1.32	0.42
18H1	0.78	9.09	3.19	1.29	0.40
18H2	0.70	8.64	3.32	1.21	0.41

These tests were run with the complete set of polynomials corresponding to the original EGR linkage adjustment (Figure B-8).

Table 11 shows the results of tests 15 and 19. Again, confirmation was excellent. Both of these tests were conducted with the EGR valve completely open for the duration of the test.

TABLE 11. CONFIRMATION OF TEST 15 DATA

Test No.	Emissions, g/hp-hr				BSFC, lb/hp-hr
	HC	CO	NO_x	Part.	
15	0.80	14.29	2.18	2.12	0.41
19	0.82	14.34	2.23	2.17	0.41

Table 12 shows calculated % EGR derived from intake and exhaust CO_2

TABLE 12. MODAL EGR SUMMARY

Test No.	Idle	PERCENT EGR							
		% Torque, Peak Torque RPM				% Torque, Rated RPM			
		25	50	75	100	25	50	75	100
18	25	21	20	11	7	19	18	13	13
19	24	22	20	19	--	19	19	18	18

measurements. Results corresponding to test 18 (full polynomial control) and test 19 (open 1½ inch pipe) are included.

C. EGR System Evaluations at Retarded Injection Timing

To determine if a more effective NO_x-particulate balance could be achieved by changing the injection timing, the timing was retarded approximately three degrees and another series of tests was run. The series of tests included two transient hot-starts, a thirteen-mode, and a smoke test for each of three EGR programs. The first of the EGR programs was identical to that used for test 16, or the 10% smoke target at base timing. The second EGR program was targeted for 10% smoke at 3° retarded timing. The control voltages are shown in Figure B-10. The control equations for this timing were:

$$\text{Voltage}_{100} = 3.23 + 0.00107\ (\text{RPM}) - 5.27 \times 10^{-7}\ (\text{RPM})^2$$
$$\text{Voltage}_{75} = 1.08 + 0.0035\ (\text{RPM}) - 1.26 \times 10^{-6}\ (\text{RPM})^2$$
$$\text{Voltage}_{50} = 2.82 + 0.008044\ (\text{RPM}) - 2.73 \times 10^{-6}\ (\text{RPM})^2$$
$$\text{Voltage}_{25} = 2.15.$$

The third part of the series was run at 3° retarded timing with no EGR. Averages of the transient hot-starts are given in Table 13.

TABLE 13. TRANSIENT TESTS, RETARDED TIMING

Test No.	Emissions, g/hp-hr HC	CO	NO_x	Part.	BSFC, lb/hp-hr	Peak Torque	Peak Power
			3° Retard, 10% Smoke EGR for base timing				
20	0.78	5.90	2.84	1.00	0.38	1055	319
			3° Retard, 10% Smoke EGR for retarded timing				
21	0.74	5.74	3.32	0.88	0.40	1080	320
			3° Retard, No EGR				
22	0.70	2.93	6.24	0.41	0.39	1150	332
			Baseline Hot Results				
2,3	0.97	3.19	6.70	0.42	0.39	1185	340

Modal NO_x derived from 13-mode tests is shown in Table 14. Smoke test results are given in Table 15. Trace evaluations are included in the Appendix. Modal EGR percentages for the retarded-timing tests are presented in Table 16.

TABLE 14. MODAL NO_x CONCENTRATIONS

	NO_x in ppm at								
		Peak Torque RPM by % Load				Rated RPM by % Load			
Test No.	Idle	25	50	75	100	25	50	75	100
15	82	170	220	250	240	185	230	295	335
18	72	220	320	735	1125	195	295	535	700
20	70	200	250	590	820	210	300	405	570
21	73	200	460	770	410	190	255	410	595
22	73	400	900	1275	1525	275	480	730	1025
1-3	80	495	1083	1621	2058	288	537	854	1200

TABLE 15. SMOKE TEST COMPARISONS

	"Factor", Percent Opacity		
Test No.	A	B	C
3° Retard, 10% Smoke EGR for base timing			
20	21.6	15.5	27.1
3° Retard, 10% Smoke EGR for retarded timing			
21	22.2	10.2	32.3
3° Retard, No EGR			
22	7.7	3.3	10.4
Federal Limits	20	15	50

TABLE 16. MODAL EGR, RETARDED TIMING

	PERCENT EGR								
		% Torque, Peak Torque RPM				% Torque, Rated RPM			
Test No.	Idle	25	50	75	100	25	50	75	100
20	23	23	22	11	8	16	16	15	13
21	23	23	14	8	5	20	20	16	13

VII. DISCUSSION OF PROGRAM RESULTS

The results of evaluations conducted show that it is possible, with EGR on this engine, to reduce NO_x by 50% while almost passing the Federal smoke test. Some work on puff limiting could bring the smoke tests into conformity. The reduction in NO_x comes at the expense of increased CO and particulates, and some decreases in peak torque and power. Data at standard timing showed poor correlation of HC vs. NO_x (a regression analysis gave a correlation coefficient (r^2) of 0.12). The three tests performed at retarded timing show a slight increase in HC as NO_x decreases. Even with the increase, CO stays well below current and proposed limits. Particulate, however, doubled or tripled and would be of great concern relative to any particulate standard which has been proposed. Peak torque loss averaged 9%, while peak power loss averaged 5%.

The 67% NO_x reduction obtained in test 15 (wide-open 1½ inch pipe) came at the cost of a peak torque decrease by 42%, and a peak power loss of 13%. The results of this test, however, are useful in defining the NO_x-particulate trade-off curve as given in Figure 5. Note also in this Figure that the three sets of points obtained at retarded timing indicate a better NO_x-particulate balance than did the standard timing tests.

A regression analysis on the BSFC versus NO_x data at standard timing (hot-starts only) yielded the equation BSFC = 0.428 - 0.004 (NO_x), which indicates a very slight increase in BSFC as NO_x is reduced. However, the correlation coefficient was only 0.20, so these data must be viewed as inconclusive. Only three retarded-timing conditions were run and a regression analysis shows a correlation coefficient of 0.23. More testing and/or calibration strategy work would be needed to explore this relationship in detail.

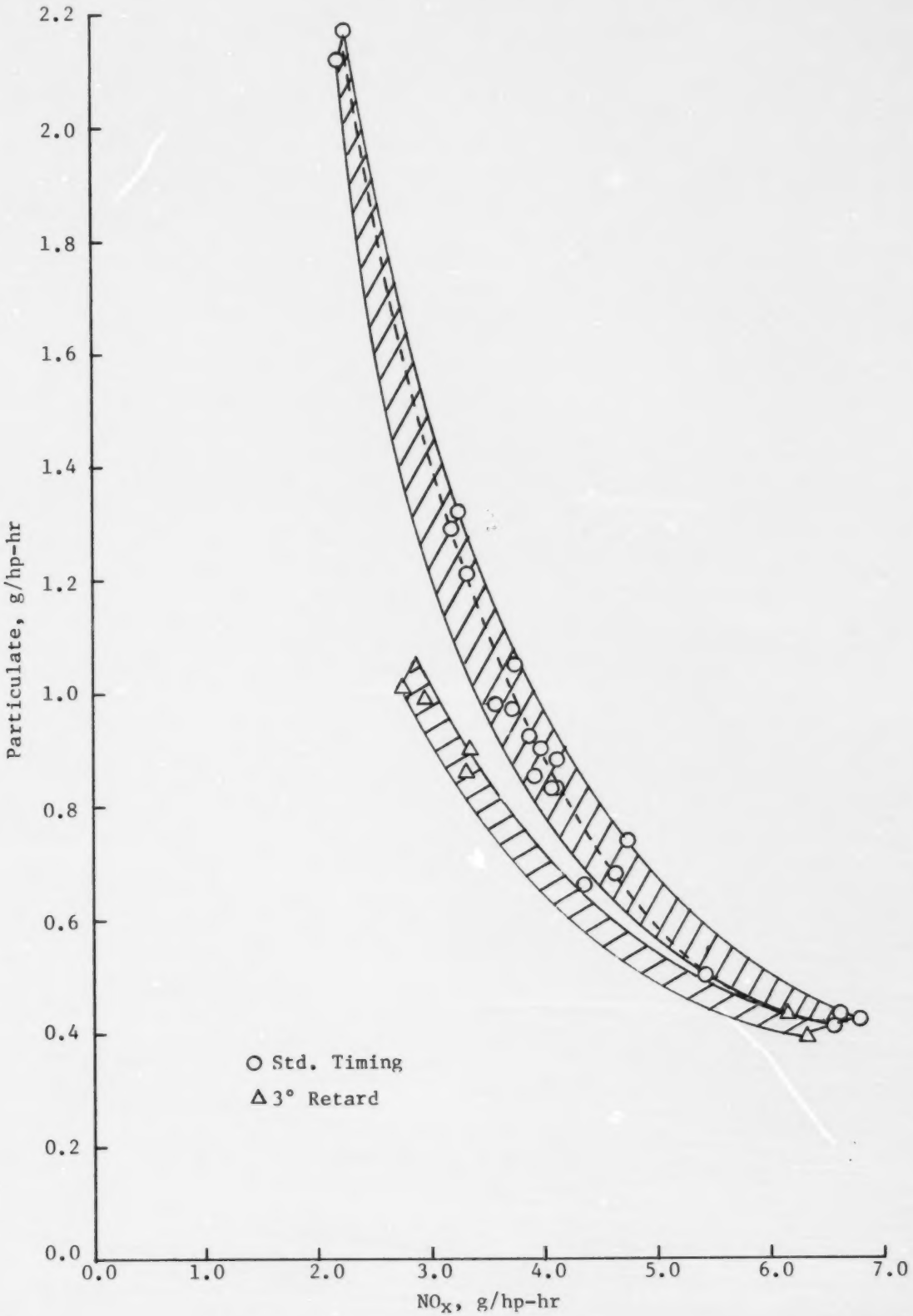

Figure 5. NO_x - particulate trade-off

APPENDICES

A. Computer Printouts and Smoke Trace Evaluations

B. EGR System Control Voltage Schedules

APPENDIX A

COMPUTER PRINTOUTS AND SMOKE TRACE EVALUATIONS

A-2 through A-32	Transient Test Computer Printouts
A-33 through A-43	13-Mode Computer Printouts
A-44 through A-49	Smoke Trace Evaluations

ENGINE EMISSION RESULTS
C-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 0 CUMMINS
ENGINE 0.0 L(0. CID)
CVS NO. 11

TEST NO.1 RUN1
DATE 5/24/84
TIME
DYNO NO. 4

DIESEL EM-597-OF
BAG CART NO. 1

BAROMETER 743.46 MM HG(29.27 IN HG)
DRY BULB TEMP. 22.2 DEG C(72.0 DEG F)

RELATIVE HUMIDITY , ENGINE-53. PCT , CVS-53. PCT
ABSOLUTE HUMIDITY 9.1 GM/KG(63.5 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	295.9	299.9	304.9	297.9
TOT. BLOWER RATE SCMM (SCFM)	60.10 (2122.3)	60.11 (2122.4)	60.12 (2123.0)	60.10 (2122.0)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.88)	.05 (1.88)	.05 (1.88)	.05 (1.88)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	296.7 (10476.)	300.7 (10618.)	305.8 (10798.)	298.6 (10545.)
HC SAMPLE METER/RANGE/PPM	44.1/11/ 44.	42.2/11/ 42.	64.2/11/ 64.	41.6/11/ 42.
HC BCKGRD METER/RANGE/PPM	9.8/ 1/ 10.	11.0/ 1/ 11.	10.0/ 1/ 10.	10.3/ 1/ 10.
CO SAMPLE METER/RANGE/PPM	50.4/13/ 48.	57.6/13/ 55.	57.9/13/ 55.	63.4/13/ 61.
CO BCKGRD METER/RANGE/PPM	1.1/13/ 1.	1.4/13/ 1.	1.4/13/ 1.	1.3/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	89.8/12/ .40	69.0/11/ .59	75.3/ 3/ 1.37	88.8/12/ .40
CO2 BCKGRD METER/RANGE/PCT	13.6/12/ .05	7.9/11/ .05	3.1/ 3/ .05	13.3/12/ .05
NOX SAMPLE METER/RANGE/PPM	28.2/ 2/ 28.	44.8/ 2/ 45.	46.3/ 3/ 139.	33.9/ 2/ 34.
NOX BCKGRD METER/RANGE/PPM	.2/ 2/ 0.	.3/ 2/ 0.	.1/ 3/ 0.	.4/ 2/ 0.
DILUTION FACTOR	32.64	22.25	9.68	33.03
HC CONCENTRATION PPM	35.	32.	55.	32.
CO CONCENTRATION PPM	45.	52.	52.	58.
CO2 CONCENTRATION PCT	.36	.55	1.33	.35
NOX CONCENTRATION PPM	28.0	44.5	138.6	33.5
HC MASS GRAMS	5.92	5.49	9.74	5.45
CO MASS GRAMS	15.70	18.28	18.43	20.32
CO2 MASS GRAMS	1936.4	3023.1	7446.7	1922.0
NOX MASS GRAMS	15.89	25.60	81.07	19.14
FUEL KG (LB)	.628 (1.38)	.973 (2.15)	2.380 (5.25)	.625 (1.38)
KW HR (HP HR)	2.13 (2.86)	3.37 (4.52)	10.30 (13.81)	2.39 (3.21)
BSHC G/KW HR (G/HP HR)	2.77 (2.07)	1.63 (1.21)	.95 (.71)	2.28 (1.70)
BSCO G/KW HR (G/HP HR)	7.36 (5.49)	5.42 (4.05)	1.79 (1.33)	8.49 (6.33)
BSCO2 G/KW HR (G/HP HR)	907.96 (677.07)	896.91 (668.82)	723.11 (539.23)	802.95 (598.76)
BSNOX G/KW HR (G/HP HR)	7.45 (5.56)	7.59 (5.66)	7.87 (5.87)	8.00 (5.96)
BSFC KG/KW HR (LB/HP HR)	.294 (.484)	.289 (.475)	.231 (.380)	.261 (.429)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	18.20 (24.40)
BSHC G/KW HR (G/HP HR)	1.46 (1.09)
BSCO G/KW HR (G/HP HR)	4.00 (2.98)
BSCO2 G/KW HR (G/HP HR)	787. (587.)
BSNOX G/KW HR (G/HP HR)	7.79 (5.81)
BSFC KG/KW HR (LB/HP HR)	.253 (.416)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES		
	GRAMS/TEST	12.26
	G/KWHR(G/HPHR)	.67 (.50)
	G/KG FUEL (G/LB FUEL)	2.66 (1.21)
	FILTER EFF.	95.0

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 0 CUMMINS
ENGINE 0.0 L(0. CID)
CVS NO. 11

TEST NO.1 RUN1
DATE 5/24/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CAPT NO. 1

BAROMETER 742.95 MM HG(29.25 IN HG)
DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)

RELATIVE HUMIDITY , ENGINE-48. PCT , CVS-57. PCT
ABSOLUTE HUMIDITY 9.4 GM/KG(65.9 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	295.9	299.9	305.0	297.8
TOT. BLOWER RATE SCMM (SCFM)	59.98 (2117.7)	59.98 (2117.9)	59.97 (2117.7)	59.97 (2117.5)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.85)	.05 (1.85)	.05 (1.85)	.05 (1.85)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	296.0 (10453.)	300.1 (10595.)	305.1 (10774.)	297.9 (10519.)
HC SAMPLE METER/RANGE/PPM	33.0/11/ 33.	36.7/11/ 37.	32.7/11/ 33.	36.7/11/ 37.
HC BCKGRD METER/RANGE/PPM	6.8/ 1/ 7.	7.5/ 1/ 8.	6.3/ 1/ 6.	6.3/ 1/ 6.
CO SAMPLE METER/RANGE/PPM	58.5/13/ 56.	55.1/13/ 52.	48.8/13/ 46.	59.6/13/ 57.
CO BCKGRD METER/RANGE/PPM	1.3/13/ 1.	1.3/13/ 1.	1.4/13/ 1.	1.4/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	88.3/12/ .39	67.2/11/ .57	72.8/ 3/ 1.32	88.4/12/ .39
CO2 BCKGRD METER/RANGE/PCT	13.5/12/ .05	7.6/11/ .04	2.7/ 3/ .04	13.1/12/ .04
NOX SAMPLE METER/RANGE/PPM	33.2/ 2/ 33.	53.3/ 2/ 53.	52.5/ 3/ 158.	38.5/ 2/ 39.
NOX BCKGRD METER/RANGE/PPM	.4/ 2/ 0.	.5/ 2/ 1.	.1/ 3/ 0.	.4/ 2/ 0.
DILUTION FACTOR	33.39	23.12	10.08	33.30
HC CONCENTRATION PPM	26.	30.	27.	31.
CO CONCENTRATION PPM	53.	50.	43.	54.
CO2 CONCENTRATION PCT	.35	.53	1.28	.35
NOX CONCENTRATION PPM	32.8	52.8	157.2	38.1
HC MASS GRAMS	4.51	5.11	4.76	5.25
CO MASS GRAMS	18.38	17.38	15.21	18.86
CO2 MASS GRAMS	1885.3	2905.9	7173.9	1908.0
NOX MASS GRAMS	18.58	30.31	91.75	21.71
FUEL KG (LB)	.611 (1.35)	.935 (2.06)	2.287 (5.04)	.620 (1.37)
KW HR (HP HR)	2.34 (3.14)	3.47 (4.65)	10.28 (13.78)	2.39 (3.21)
BSHC G/KW HR (G/HP HR)	1.92 (1.44)	1.47 (1.10)	.46 (.35)	2.19 (1.63)
BSCO G/KW HR (G/HP HR)	7.85 (5.85)	5.01 (3.74)	1.48 (1.10)	7.88 (5.87)
BSCO2 G/KW HR (G/HP HR)	805.15 (600.40)	838.02 (624.91)	698.14 (520.60)	797.09 (594.39)
BSNOX G/KW HR (G/HP HR)	7.93 (5.92)	8.74 (6.52)	8.93 (6.66)	9.07 (6.76)
BSFC KG/KW HR (LB/HP HR)	.261 (.429)	.270 (.443)	.223 (.366)	.259 (.426)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	18.48 (24.78)
BSHC G/KW HR (G/HP HR)	1.06 (.79)
BSCO G/KW HR (G/HP HR)	3.78 (2.82)
BSCO2 G/KW HR (G/HP HR)	751. (560.)
BSNOX G/KW HR (G/HP HR)	8.79 (6.55)
BSFC KG/KW HR (LB/HP HR)	.241 (.396)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	10.15
	G/KWHR(G/HPHR)	.55 (.41)
	G/KG FUEL (G/LB FUEL)	2.28 (1.03)
	FILTER EFF.	94.5

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

BAROMETER 739.65 MM HG(29.12 IN HG)
DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)

BAG RESULTS
- BAG NUMBER
- DESCRIPTION
- TIME SECONDS
- TOT. BLOWER RATE SCMM (SCFM)
- TOT. 20X20 RATE SCMM (SCFM)
- TOT. 90MM RATE SCMM (SCFM)
- TOT. AUX. SAMPLE RATE SCMM (SCFM)
- TOTAL FLOW STD. CU. METRES(SCF)

- HC SAMPLE METER/RANGE/PPM
- HC BCKGRD METER/RANGE/PPM
- CO SAMPLE METER/RANGE/PPM
- CO BCKGRD METER/RANGE/PPM
- CO2 SAMPLE METER/RANGE/PCT
- CO2 BCKGRD METER/RANGE/PCT
- NOX SAMPLE METER/RANGE/PPM
- NOX BCKGRD METER/RANGE/PPM

- DILUTION FACTOR
- HC CONCENTRATION PPM
- CO CONCENTRATION PPM
- CO2 CONCENTRATION PCT
- NOX CONCENTRATION PPM

- HC MASS GRAMS
- CO MASS GRAMS
- CO2 MASS GRAMS
- NOX MASS GRAMS
- FUEL KG (LB)
- KW HR (HP HR)

- BSHC G/KW HR (G/HP HR)
- BSCO G/KW HR (G/HP HR)
- BSCO2 G/KW HR (G/HP HR)
- BSNOX G/KW HR (G/HP HR)
- BSFC KG/KW HR (LB/HP HR)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	18.20 (24.40)
BSHC G/KW HR (G/HP HR)	1.61 (1.20)
BSCO G/KW HR (G/HP HR)	3.93 (2.93)
BSCO2 G/KW HR (G/HP HR)	768. (573.)
BSNOX G/KW HR (G/HP HR)	7.81 (5.83)
BSFC KG/KW HR (LB/HP HR)	.247 (.406)

ENGINE EMISSION RESULTS
C-TRANS.

PROJECT NO. 03-7338-015

TEST NO.2 RUN1
DATE 5/25/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

RELATIVE HUMIDITY , ENGINE-47. PCT , CVS-60. PCT
ABSOLUTE HUMIDITY 8.8 GM/KG(61.9 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

1 NYNF	2 LANF	3 LAF	4 NYNF
295.9	300.0	304.9	297.8
59.43 (2098.6)	59.40 (2097.3)	59.44 (2099.0)	59.42 (2098.0)
0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
.05 (1.86)	.05 (1.86)	.05 (1.86)	.05 (1.86)
0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
293.4 (10359.)	297.2 (10496.)	302.3 (10676.)	295.2 (10422.)
25.5/12/ 51.	21.5/12/ 43.	33.2/12/ 66.	21.2/12/ 42.
8.9/ 1/ 9.	8.7/ 1/ 9.	8.2/ 1/ 8.	8.0/ 1/ 8.
73.8/13/ 72.	74.3/13/ 73.	65.5/13/ 63.	69.4/13/ 67.
30.2/13/ 28.	19.8/13/ 18.	12.6/13/ 11.	8.3/13/ 7.
89.0/12/ .40	67.1/11/ .57	75.5/ 3/ 1.38	89.0/12/ .40
14.9/12/ .05	8.7/11/ .05	3.1/ 3/ .05	8.2/11/ .05
29.5/ 2/ 30.	46.7/ 2/ 47.	46.9/ 3/ 141.	33.9/ 2/ 34.
.6/ 2/ 1.	1.2/ 2/ 1.	.1/ 3/ 0.	.5/ 2/ 1.
32.77	23.06	9.64	32.88
42.	35.	59.	35.
44.	54.	50.	59.
.35	.52	1.33	.35
28.9	45.6	140.4	33.4
7.18	5.93	10.31	5.89
15.01	18.60	17.73	20.12
1864.5	2836.9	7385.4	1894.7
16.22	25.89	81.20	18.86
.606 (1.34)	.915 (2.02)	2.361 (5.20)	.617 (1.36)
2.17 (2.91)	3.32 (4.45)	10.30 (13.81)	2.41 (3.23)
3.31 (2.47)	1.79 (1.33)	1.00 (.75)	2.45 (1.82)
6.92 (5.16)	5.60 (4.18)	1.72 (1.28)	8.35 (6.23)
859.22 (640.72)	854.92 (637.51)	717.16 (534.79)	786.63 (586.59)
7.48 (5.58)	7.80 (5.82)	7.88 (5.88)	7.83 (5.84)
.279 (.459)	.276 (.453)	.229 (.377)	.256 (.421)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES GRAMS/TEST	11.98
G/KWHR(G/HPHR)	.66 (.49)
G/KG FUEL (G/LB FUEL)	2.66 (1.21)
FILTER EFF.	95.1

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-016

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.2 RUN1
DATE 5/25/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 736.85 MM HG(29.01 IN HG)
DRY BULB TEMP. 28.3 DEG C(83.0 DEG F)

RELATIVE HUMIDITY , ENGINE-36. PCT , CVS-58. PCT
ABSOLUTE HUMIDITY 8.9 GM/KG(62.6 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	296.1	300.1	305.0	297.9
TOT. BLOWER RATE SCMM (SCFM)	59.22 (2091.0)	59.24 (2091.8)	59.25 (2092.0)	59.24 (2091.8)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.82)	.05 (1.82)	.05 (1.82)	.05 (1.82)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	292.5 (10328.)	296.6 (10472.)	301.4 (10644.)	294.4 (10395.)
HC SAMPLE METER/RANGE/PPM	40.2/11/ 40.	45.1/11/ 45.	31.8/11/ 32.	42.4/11/ 42.
HC BCKGRD METER/RANGE/PPM	6.8/ 1/ 7.	6.3/ 1/ 6.	6.3/ 1/ 6.	6.2/ 1/ 6.
CO SAMPLE METER/RANGE/PPM	73.7/13/ 72.	62.2/13/ 60.	48.4/13/ 46.	66.5/13/ 64.
CO BCKGRD METER/RANGE/PPM	.2/13/ 0.	.9/13/ 1.	.8/13/ 1.	.8/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	49.4/11/ .38	62.7/11/ .52	72.5/ 3/ 1.32	49.3/11/ .38
CO2 BCKGRD METER/RANGE/PCT	7.5/11/ .04	7.7/11/ .04	3.2/ 3/ .05	7.4/11/ .04
NOX SAMPLE METER/RANGE/PPM	36.3/ 2/ 36.	54.7/ 2/ 55.	52.9/ 3/ 159.	38.3/ 2/ 38.
NOX BCKGRD METER/RANGE/PPM	.2/ 2/ 0.	.3/ 2/ 0.	.1/ 3/ 0.	.2/ 2/ 0.
DILUTION FACTOR	34.57	25.35	10.13	34.70
HC CONCENTRATION PPM	34.	39.	26.	36.
CO CONCENTRATION PPM	70.	57.	43.	62.
CO2 CONCENTRATION PCT	.33	.48	1.27	.33
NOX CONCENTRATION PPM	36.1	54.4	158.4	38.1
HC MASS GRAMS	5.66	6.68	4.54	6.17
CO MASS GRAMS	23.89	19.79	15.06	21.26
CO2 MASS GRAMS	1791.8	2581.9	7014.7	1801.3
NOX MASS GRAMS	20.20	30.86	91.33	21.45
FUEL KG (LB)	.586 (1.29)	.835 (1.84)	2.236 (4.93)	.588 (1.30)
KW HR (HP HR)	2.31 (3.10)	3.36 (4.51)	10.01 (13.43)	2.31 (3.10)
BSHC G/KW HR (G/HP HR)	2.45 (1.83)	1.99 (1.48)	.45 (.34)	2.67 (1.99)
BSCO G/KW HR (G/HP HR)	10.33 (7.70)	5.88 (4.39)	1.50 (1.12)	9.20 (6.86)
BSCO2 G/KW HR (G/HP HR)	775.12 (578.01)	767.70 (572.48)	700.44 (522.31)	779.21 (581.06)
BSNOX G/KW HR (G/HP HR)	8.74 (6.51)	9.18 (6.84)	9.12 (6.80)	9.28 (6.92)
BSFC KG/KW HR (LB/HP HR)	.253 (.417)	.248 (.408)	.223 (.367)	.254 (.418)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	18.00 (24.14)
BSHC G/KW HR (G/HP HR)	1.28 (.95)
BSCO G/KW HR (G/HP HR)	4.44 (3.31)
BSCO2 G/KW HR (G/HP HR)	733. (546.)
BSNOX G/KW HR (G/HP HR)	9.10 (6.79)
BSFC KG/KW HR (LB/HP HR)	.236 (.388)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	10.19
	G/KWHR(G/HPHR)	.57 (.42)
	G/KG FUEL (G/LB FUEL)	2.40 (1.09)
	FILTER EFF.	95.7

ENGINE EMISSION RESULTS
C-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.3 RUN1
DATE 5/28/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 743.46 MM HG(29.27 IN HG)
DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)

RELATIVE HUMIDITY , ENGINE-50. PCT , CVS-67. PCT
ABSOLUTE HUMIDITY 8.8 GM/KG(61.3 GRAINS/LB)

NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER				
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	295.9	299.9	304.9	297.9
TOT. BLOWER RATE SCMM (SCFM)	59.78 (2110.7)	59.78 (2110.8)	59.78 (2111.0)	59.77 (2110.4)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.89)	.05 (1.89)	.05 (1.89)	.05 (1.89)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	295.1 (10418.)	299.1 (10560.)	304.1 (10737.)	297.0 (10487.)
HC SAMPLE METER/RANGE/PPM	28.1/12/ 56.	25.4/12/ 51.	34.9/12/ 70.	26.2/12/ 52.
HC BCKGRD METER/RANGE/PPM	7.3/ 1/ 7.	8.2/ 1/ 8.	8.5/ 1/ 9.	8.7/ 1/ 9.
CO SAMPLE METER/RANGE/PPM	54.3/13/ 52.	57.0/13/ 54.	55.5/13/ 53.	63.4/13/ 61.
CO BCKGRD METER/RANGE/PPM	2.7/13/ 2.	2.9/13/ 3.	2.6/13/ 2.	1.8/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	24.0/ 3/ .39	33.4/ 3/ .56	73.2/ 3/ 1.33	22.3/ 3/ .36
CO2 BCKGRD METER/RANGE/PCT	2.9/ 3/ .04	2.8/ 3/ .04	3.1/ 3/ .05	2.9/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	29.0/ 2/ 29.	45.5/ 2/ 46.	45.1/ 3/ 135.	33.6/ 2/ 34.
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ 0.	.3/ 2/ 0.	.1/ 3/ 0.	.4/ 2/ 0.
DILUTION FACTOR	33.43	23.63	9.99	36.01
HC CONCENTRATION PPM	49.	43.	62.	44.
CO CONCENTRATION PPM	48.	50.	48.	58.
CO2 CONCENTRATION PCT	.35	.52	1.29	.32
NOX CONCENTRATION PPM	28.7	45.2	135.0	33.2
HC MASS GRAMS	8.37	7.42	10.90	7.54
CO MASS GRAMS	16.40	17.46	17.08	19.98
CO2 MASS GRAMS	1875.5	2823.5	7164.0	1728.0
NOX MASS GRAMS	16.20	25.86	78.52	18.86
FUEL KG (LB)	.611 (1.35)	.911 (2.01)	2.291 (5.05)	.565 (1.25)
KW HR (HP HR)	2.10 (2.81)	3.30 (4.42)	9.96 (13.36)	2.26 (3.03)
BSHC G/KW HR (G/HP HR)	3.99 (2.98)	2.25 (1.68)	1.09 (.82)	3.34 (2.49)
BSCO G/KW HR (G/HP HR)	7.83 (5.84)	5.30 (3.95)	1.71 (1.28)	8.84 (6.59)
BSCO2 G/KW HR (G/HP HR)	895.07 (667.45)	856.66 (638.81)	719.09 (536.23)	764.78 (570.30)
BSNOX G/KW HR (G/HP HR)	7.73 (5.76)	7.85 (5.85)	7.88 (5.88)	8.35 (6.23)
BSFC KG/KW HR (LB/HP HR)	.292 (.480)	.277 (.455)	.230 (.378)	.250 (.411)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.61 (23.62)
BSHC G/KW HR (G/HP HR)	1.94 (1.45)
BSCO G/KW HR (G/HP HR)	4.03 (3.00)
BSCO2 G/KW HR (G/HP HR)	772. (575.)
BSNOX G/KW HR (G/HP HR)	7.92 (5.90)
BSFC KG/KW HR (LB/HP HR)	.249 (.409)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES GRAMS/TEST	12.70
G/KWHR(G/HPHR)	.72 (.54)
G/KG FUEL (G/LB FUEL)	2.90 (1.32)
FILTER EFF.	94.6

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.3 RUN1
DATE 5/28/84
TIME
DYNO NO. 4

DIESEL FM-597-F
BAG CART NO. 1

BAROMETER 743.46 MM HG(29.27 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-44. PCT , CVS-67. PCT
ABSOLUTE HUMIDITY 8.9 GM/KG(62.3 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER				
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	295.9	299.9	304.5	297.9
TOT. BLOWER RATE SCMM (SCFM)	59.78 (2110.7)	59.79 (2111.2)	59.89 (2114.7)	59.77 (2110.4)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.87)	.05 (1.87)	.05 (1.87)	.05 (1.87)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	295.1 (10418.)	299.1 (10562.)	304.2 (10742.)	297.0 (10487.)
HC SAMPLE METER/RANGE/PPM	42.2/11/ 42.	45.4/11/ 45.	35.5/11/ 36.	47.7/11/ 48.
HC BCKGRD METER/RANGE/PPM	9.0/ 1/ 9.	9.1/ 1/ 9.	9.0/ 1/ 9.	8.8/ 1/ 9.
CO SAMPLE METER/RANGE/PPM	65.6/13/ 63.	58.6/13/ 56.	46.6/13/ 44.	63.5/13/ 61.
CO BCKGRD METER/RANGE/PPM	1.8/13/ 2.	1.7/13/ 2.	1.7/13/ 2.	2.0/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	23.5/ 3/ .38	32.1/ 3/ .53	70.3/ 3/ 1.27	22.6/ 3/ .37
CO2 BCKGRD METER/RANGE/PCT	2.5/ 3/ .04	2.4/ 3/ .04	2.9/ 3/ .04	2.5/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	35.4/ 2/ 35.	53.2/ 2/ 53.	49.8/ 3/ 149.	36.7/ 2/ 37.
NOX BCKGRD METER/RANGE/PPM	.2/ 2/ 0.	.1/ 2/ 0.	.1/ 3/ 0.	.5/ 2/ 1.
DILUTION FACTOR	34.19	24.67	10.48	35.57
HC CONCENTRATION PPM	34.	37.	27.	39.
CO CONCENTRATION PPM	60.	53.	40.	58.
CO2 CONCENTRATION PCT	.34	.50	1.23	.33
NOX CONCENTRATION PPM	35.2	53.1	149.1	36.2
HC MASS GRAMS	5.70	6.33	4.80	6.70
CO MASS GRAMS	20.62	18.38	14.30	19.95
CO2 MASS GRAMS	1861.0	2727.6	6851.4	1788.7
NOX MASS GRAMS	19.87	30.38	86.76	20.57
FUEL KG (LB)	.606 (1.34)	.880 (1.94)	2.184 (4.82)	.584 (1.29)
KW HR (HP HR)	2.25 (3.02)	3.36 (4.50)	9.96 (13.35)	2.21 (2.96)
BSHC G/KW HR (G/HP HR)	2.53 (1.89)	1.89 (1.41)	.48 (.36)	3.03 (2.26)
BSCO G/KW HR (G/HP HR)	9.16 (6.83)	5.48 (4.08)	1.44 (1.07)	9.04 (6.74)
BSCO2 G/KW HR (G/HP HR)	826.36 (616.22)	812.82 (606.12)	688.23 (513.21)	810.36 (604.29)
BSNOX G/KW HR (G/HP HR)	8.82 (6.58)	9.05 (6.75)	8.71 (6.50)	9.32 (6.95)
BSFC KG/KW HR (LB/HP HR)	.269 (.442)	.262 (.431)	.219 (.361)	.264 (.435)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.77 (23.83)
BSHC G/KW HR (G/HP HR)	1.32 (.99)
BSCO G/KW HR (G/HP HR)	4.12 (3.07)
BSCO2 G/KW HR (G/HP HR)	744. (555.)
BSNOX G/KW HR (G/HP HR)	8.87 (6.61)
BSFC KG/KW HR (LB/HP HR)	.239 (.394)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES GRAMS/TEST	10.16
G/KWHR(G/HPHR)	.57 (.43)
G/KG FUEL (G/LB FUEL)	2.39 (1.08)
FILTER EFF.	95.5

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.C-10-4RUN1
DATE 6/ 5/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 736.35 MM HG(28.99 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-43. PCT , CVS-57. PCT
ABSOLUTE HUMIDITY 8.8 GM/KG(61.5 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER				
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	295.6	299.7	304.8	297.7
TOT. BLOWER RATE SCMM (SCFM)	59.48 (2100.3)	59.48 (2100.4)	59.50 (2100.9)	59.48 (2100.3)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.76)	.05 (1.76)	.05 (1.76)	.05 (1.76)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	293.3 (10356.)	297.4 (10500.)	302.5 (10681.)	295.4 (10430.)
HC SAMPLE METER/RANGE/PPM	17.4/12/ 35.	20.9/12/ 42.	15.0/12/ 30.	18.3/12/ 37.
HC BCKGRD METER/RANGE/PPM	7.2/ 1/ 7.	7.5/ 1/ 8.	7.4/ 1/ 7.	7.7/ 1/ 8.
CO SAMPLE METER/RANGE/PPM	93.9/13/ 95.	54.5/12/ 117.	69.0/12/ 156.	47.9/12/ 101.
CO BCKGRD METER/RANGE/PPM	.5/13/ 0.	.1/12/ 0.	.5/12/ 1.	.3/12/ 1.
CO2 SAMPLE METER/RANGE/PCT	81.3/12/ .35	65.0/11/ .54	71.8/ 3/ 1.30	80.9/12/ .35
CO2 BCKGRD METER/RANGE/PCT	12.2/12/ .04	7.2/11/ .04	2.8/ 3/ .04	12.1/12/ .04
NOX SAMPLE METER/RANGE/PPM	62.6/ 1/ 19.	31.1/ 2/ 31.	94.6/ 2/ 95.	67.3/ 1/ 20.
NOX BCKGRD METER/RANGE/PPM	1.0/ 1/ 0.	.3/ 2/ 0.	.6/ 2/ 1.	.8/ 1/ 0.
DILUTION FACTOR	36.73	23.91	10.16	36.88
HC CONCENTRATION PPM	28.	35.	23.	29.
CO CONCENTRATION PPM	92.	114.	149.	98.
CO2 CONCENTRATION PCT	.31	.51	1.26	.31
NOX CONCENTRATION PPM	18.3	30.8	94.1	19.8
HC MASS GRAMS	4.71	5.94	4.06	4.97
CO MASS GRAMS	31.48	39.35	52.38	33.59
CO2 MASS GRAMS	1674.4	2750.1	6991.0	1676.0
NOX MASS GRAMS	10.28	17.52	54.41	11.18
FUEL KG (LB)	.551 (1.22)	.898 (1.98)	2.247 (4.95)	.553 (1.22)
KW HR (HP HR)	2.04 (2.74)	3.23 (4.33)	9.58 (12.85)	2.10 (2.81)
BSHC G/KW HR (G/HP HR)	2.31 (1.72)	1.84 (1.37)	.42 (.32)	2.37 (1.77)
BSCO G/KW HR (G/HP HR)	15.41 (11.49)	12.19 (9.09)	5.47 (4.08)	16.03 (11.95)
BSCO2 G/KW HR (G/HP HR)	819.47 (611.08)	851.73 (635.13)	729.57 (544.04)	799.86 (596.45)
BSNOX G/KW HR (G/HP HR)	5.03 (3.75)	5.43 (4.05)	5.68 (4.23)	5.33 (3.98)
BSFC KG/KW HR (LB/HP HR)	.270 (.444)	.278 (.457)	.234 (.385)	.264 (.434)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	16.95 (22.73)
BSHC G/KW HR (G/HP HR)	1.16 (.87)
BSCO G/KW HR (G/HP HR)	9.25 (6.90)
BSCO2 G/KW HR (G/HP HR)	772. (576.)
BSNOX G/KW HR (G/HP HR)	5.51 (4.11)
BSFC KG/KW HR (LB/HP HR)	.251 (.412)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES

GRAMS/TEST	19.97
G/KWHR(G/HPHR)	1.18 (.88)
G/KG FUEL (G/LB FUEL)	4.70 (2.13)
FILTER EFF.	98.2

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO. C10-5 RUN
DATE 6/12/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 742.95 MM HG(29.25 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-43. PCT , CVS-66. PCT
ABSOLUTE HUMIDITY 8.7 GM/KG(60.9 GRAINS/LB)

NOX HUMIDITY C.F. 1.0000

BAG RESULTS	1	2	3	4
BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	295.9	299.8	304.8	297.8
TOT. BLOWER RATE SCMM (SCFM)	59.87 (2114.1)	59.90 (2115.0)	59.90 (2115.2)	59.89 (2114.6)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.89)	.05 (1.89)	.05 (1.89)	.05 (1.89)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	295.5 (10435.)	299.6 (10578.)	304.6 (10755.)	297.5 (10505.)
HC SAMPLE METER/RANGE/PPM	36.0/11/ 36.	40.7/11/ 41.	34.2/11/ 34.	39.5/11/ 39.
HC BCKGRD METER/RANGE/PPM	6.9/ 1/ 7.	6.9/ 1/ 7.	7.0/ 1/ 7.	7.0/ 1/ 7.
CO SAMPLE METER/RANGE/PPM	70.1/13/ 68.	70.3/13/ 68.	65.1/13/ 63.	77.9/13/ 77.
CO BCKGRD METER/RANGE/PPM	.2/13/ 0.	.7/13/ 1.	.9/13/ 1.	1.4/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	84.1/12/ .37	66.1/11/ .56	72.6/ 3/ 1.32	83.5/12/ .36
CO2 BCKGRD METER/RANGE/PCT	11.6/12/ .04	6.8/11/ .04	2.7/ 3/ .04	11.9/12/ .04
NOX SAMPLE METER/RANGE/PPM	88.0/ 1/ 26.	44.6/ 2/ 45.	42.6/ 3/ 128.	97.1/ 1/ 29.
NOX BCKGRD METER/RANGE/PPM	.8/ 1/ 0.	.2/ 2/ 0.	.1/ 3/ 0.	.8/ 1/ 0.
DILUTION FACTOR	35.43	23.57	10.10	35.64
HC CONCENTRATION PPM	29.	34.	28.	33.
CO CONCENTRATION PPM	66.	66.	59.	73.
CO2 CONCENTRATION PCT	.33	.52	1.28	.33
NOX CONCENTRATION PPM	25.9	44.4	127.5	28.7
HC MASS GRAMS	4.99	5.89	4.89	5.60
CO MASS GRAMS	22.76	22.91	21.00	25.44
CO2 MASS GRAMS	1784.6	2854.3	7138.1	1772.1
NOX MASS GRAMS	14.67	25.44	74.28	16.30
FUEL KG (LB)	.582 (1.28)	.922 (2.03)	2.279 (5.02)	.580 (1.28)
KW HR (HP HR)	2.24 (3.01)	3.47 (4.66)	10.01 (13.42)	2.24 (3.01)
BSHC G/KW HR (G/HP HR)	2.23 (1.66)	1.70 (1.26)	.49 (.36)	2.50 (1.86)
BSCO G/KW HR (G/HP HR)	10.14 (7.56)	6.59 (4.92)	2.10 (1.56)	11.33 (8.45)
BSCO2 G/KW HR (G/HP HR)	795.07 (592.88)	821.40 (612.52)	713.29 (531.90)	789.49 (588.72)
BSNOX G/KW HR (G/HP HR)	6.53 (4.87)	7.32 (5.46)	7.42 (5.54)	7.26 (5.42)
BSFC KG/KW HR (LB/HP HR)	.259 (.426)	.265 (.436)	.228 (.374)	.258 (.425)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.97 (24.10)
BSHC G/KW HR (G/HP HR)	1.19 (.89)
BSCO G/KW HR (G/HP HR)	5.12 (3.82)
BSCO2 G/KW HR (G/HP HR)	754. (562.)
BSNOX G/KW HR (G/HP HR)	7.27 (5.42)
BSFC KG/KW HR (LB/HP HR)	.243 (.399)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PAPTICULATE RATES	GRAMS/TEST	12.10
	G/KWHR(G/HPHR)	.67 (.50)
	G/KG FUEL (G/LB FUEL)	2.77 (1.26)
	FILTER EFF.	95.5

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.C10-6 RUN2
DATE 6/15/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 743.20 MM HG(29.26 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-60. PCT , CVS-60. PCT
ABSOLUTE HUMIDITY 12.1 GM/KG(84.7 GRAINS/LB)

NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER				
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	295.9	299.9	304.9	297.8
TOT. BLOWER RATE SCMM (SCFM)	58.45 (2063.8)	58.45 (2064.0)	58.47 (2064.5)	58.46 (2064.3)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.88)	.05 (1.88)	.05 (1.88)	.05 (1.88)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	288.5 (10187.)	292.4 (10326.)	297.4 (10501.)	290.4 (10255.)
HC SAMPLE METER/RANGE/PPM	33.9/11/ 34.	38.1/11/ 38.	32.0/11/ 32.	41.0/11/ 41.
HC BCKGRD METER/RANGE/PPM	12.5/ 1/ 13.	12.2/ 1/ 12.	12.2/ 1/ 12.	12.0/ 1/ 12.
CO SAMPLE METER/RANGE/PPM	79.4/13/ 78.	85.6/13/ 85.	84.7/13/ 84.	89.1/13/ 89.
CO BCKGRD METER/RANGE/PPM	.5/13/ 0.	.6/13/ 1.	.9/13/ 1.	.8/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	84.7/12/ .37	66.7/11/ .56	71.1/ 3/ 1.29	84.1/12/ .37
CO2 BCKGRD METER/RANGE/PCT	15.1/12/ .05	8.7/11/ .05	3.3/ 3/ .05	14.4/12/ .05
NOX SAMPLE METER/RANGE/PPM	71.9/ 1/ 21.	35.4/ 2/ 35.	33.1/ 3/ 99.	77.7/ 1/ 23.
NOX BCKGRD METER/RANGE/PPM	.9/ 1/ 0.	.3/ 2/ 0.	.1/ 3/ 0.	.7/ 1/ 0.
DILUTION FACTOR	35.03	23.22	10.32	35.19
HC CONCENTRATION PPM	22.	26.	21.	29.
CO CONCENTRATION PPM	76.	82.	80.	86.
CO2 CONCENTRATION PCT	.32	.52	1.24	.32
NOX CONCENTRATION PPM	21.1	35.1	99.0	22.9
HC MASS GRAMS	3.62	4.46	3.60	4.91
CO MASS GRAMS	25.53	28.05	27.71	29.23
CO2 MASS GRAMS	1695.9	2765.3	6756.5	1701.9
NOX MASS GRAMS	11.66	19.64	56.32	12.73
FUEL KG (LB)	.554 (1.22)	.895 (1.97)	2.160 (4.76)	.559 (1.23)
KW HR (HP HR)	2.15 (2.88)	3.32 (4.45)	9.66 (12.96)	2.12 (2.84)
BSHC G/KW HR (G/HP HR)	1.69 (1.26)	1.34 (1.00)	.37 (.28)	2.32 (1.73)
BSCO G/KW HR (G/HP HR)	11.89 (8.86)	8.45 (6.30)	2.87 (2.14)	13.80 (10.29)
BSCO2 G/KW HR (G/HP HR)	789.66 (588.85)	833.32 (621.41)	699.12 (521.34)	803.63 (599.26)
BSNOX G/KW HR (G/HP HR)	5.43 (4.05)	5.92 (4.41)	5.83 (4.35)	6.01 (4.48)
BSFC KG/KW HR (LB/HP HR)	.258 (.424)	.270 (.444)	.223 (.367)	.264 (.434)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.25 (23.13)
BSHC G/KW HR (G/HP HR)	.96 (.72)
BSCO G/KW HR (G/HP HR)	6.41 (4.78)
BSCO2 G/KW HR (G/HP HR)	749. (559.)
BSNOX G/KW HR (G/HP HR)	5.82 (4.34)
BSFC KG/KW HR (LB/HP HR)	.242 (.397)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	15.36
	G/KWHR(G/HPHR)	.89 (.66)
	G/KG FUEL (G/LB FUEL)	3.69 (1.67)
	FILTER EFF.	97.3

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.7 RUN1
DATE 6/20/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 743.20 MM HG(29.26 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-46. PCT , CVS-56. PCT
ABSOLUTE HUMIDITY 9.3 GM/KG(65.2 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	296.0	300.0	305.0	297.9
TOT. BLOWER RATE SCMM (SCFM)	60.02 (2119.2)	60.01 (2119.0)	60.03 (2119.6)	60.01 (2119.0)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.79)	.05 (1.79)	.05 (1.79)	.05 (1.79)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	296.3 (10464.)	300.3 (10604.)	305.4 (10784.)	298.2 (10530.)
HC SAMPLE METER/RANGE/PPM	35.5/11/ 36.	41.1/11/ 41.	32.3/11/ 32.	40.3/11/ 40.
HC BCKGRD METER/RANGE/PPM	9.7/ 1/ 10.	9.6/ 1/ 10.	9.5/ 1/ 10.	9.2/ 1/ 9.
CO SAMPLE METER/RANGE/PPM	94.2/13/ 95.	49.4/12/ 104.	52.7/12/ 113.	49.5/12/ 105.
CO BCKGRD METER/RANGE/PPM	.9/13/ 1.	.5/12/ 1.	.7/12/ 1.	.6/12/ 1.
CO2 SAMPLE METER/RANGE/PCT	85.5/12/ .38	67.3/11/ .57	72.3/ 3/ 1.31	84.3/12/ .37
CO2 BCKGRD METER/RANGE/PCT	15.2/12/ .05	8.5/11/ .05	3.0/ 3/ .05	13.9/12/ .05
NOX SAMPLE METER/RANGE/PPM	63.9/ 1/ 19.	31.5/ 2/ 32.	92.4/ 2/ 92.	69.5/ 1/ 21.
NOX BCKGRD METER/RANGE/PPM	.9/ 1/ 0.	.3/ 2/ 0.	.5/ 2/ 1.	.7/ 1/ 0.
DILUTION FACTOR	34.45	22.85	10.11	34.95
HC CONCENTRATION PPM	26.	32.	24.	31.
CO CONCENTRATION PPM	92.	101.	107.	101.
CO2 CONCENTRATION PCT	.33	.52	1.27	.32
NOX CONCENTRATION PPM	18.7	31.2	91.9	20.5
HC MASS GRAMS	4.46	5.53	4.19	5.40
CO MASS GRAMS	31.80	35.14	37.90	35.05
CO2 MASS GRAMS	1765.2	2886.0	7099.5	1763.4
NOX MASS GRAMS	10.63	17.93	53.70	11.68
FUEL KG (LB)	.580 (1.28)	.938 (2.07)	2.274 (5.01)	.582 (1.28)
KW HR (HP HR)	2.13 (2.86)	3.30 (4.43)	9.66 (12.96)	2.16 (2.89)
BSHC G/KW HR (G/HP HR)	2.09 (1.56)	1.67 (1.25)	.43 (.32)	2.50 (1.87)
BSCO G/KW HP (G/HP HR)	14.91 (11.12)	10.64 (7.93)	3.92 (2.92)	16.27 (12.13)
BSCO2 G/KW HR (G/HP HR)	827.69 (617.21)	873.63 (651.46)	734.62 (547.80)	818.24 (610.16)
BSNOX G/KW HR (G/HP HR)	4.98 (3.72)	5.43 (4.05)	5.56 (4.14)	5.42 (4.04)
BSFC KG/KW HR (LB/HP HR)	.272 (.447)	.284 (.467)	.235 (.387)	.270 (.444)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	19.18
	G/KWHR(G/HPHR)	1.11 (.83)
	G/KG FUEL (G/LB FUEL)	4.39 (1.99)
	FILTER EFF.	98.7

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.26 (23.14)
BSHC G/KW HR (G/HP HR)	1.13 (.85)
BSCO G/KW HR (G/HP HR)	8.11 (6.05)
BSCO2 G/KW HR (G/HP HR)	783. (584.)
BSNOX G/KW HR (G/HP HR)	5.44 (4.06)
BSFC KG/KW HR (LB/HP HR)	.253 (.417)

ENGINE FMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.C10-8 RUN1
DATE 7/19/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 742.70 MM HG(29.24 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-48. PCT , CVS-63. PCT
ABSOLUTE HUMIDITY 9.7 GM/KG(68.2 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	295.8	299.8	304.8	297.7
TOT. BLOWER RATE SCMM (SCFM)	60.17 (2124.6)	60.15 (2124.0)	60.16 (2124.2)	60.17 (2124.7)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.75)	.05 (1.75)	.05 (1.75)	.05 (1.75)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	296.9 (10483.)	300.8 (10622.)	305.9 (10800.)	298.8 (10551.)
HC SAMPLE METER/RANGE/PPM	26.7/11/ 27.	31.4/11/ 31.	28.3/11/ 28.	25.8/11/ 26.
HC BCKGRD METER/RANGE/PPM	7.8/ 1/ 8.	8.0/ 1/ 8.	7.9/ 1/ 8.	8.8/ 1/ 9.
CO SAMPLE METER/RANGE/PPM	94.0/13/ 95.	98.1/13/ 100.	91.8/13/ 93.	98.6/13/ 100.
CO BCKGRD METER/RANGE/PPM	2.3/13/ 2.	2.5/13/ 2.	2.3/13/ 2.	2.2/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	52.2/11/ .40	68.5/11/ .59	74.6/ 3/ 1.36	89.9/12/ .40
CO2 BCKGRD METER/RANGE/PCT	7.6/11/ .04	7.7/11/ .04	2.9/ 3/ .04	13.1/12/ .04
NOX SAMPLE METER/RANGE/PPM	78.8/ 1/ 23.	36.9/ 2/ 37.	36.7/ 3/ 110.	87.5/ 1/ 26.
NOX BCKGRD METER/RANGE/PPM	1.1/ 1/ 0.	.4/ 2/ 0.	.1/ 3/ 0.	.9/ 1/ 0.
DILUTION FACTOR	32.15	22.35	9.78	32.33
HC CONCENTRATION PPM	19.	24.	21.	17.
CO CONCENTRATION PPM	90.	95.	86.	96.
CO2 CONCENTRATION PCT	.36	.54	1.32	.36
NOX CONCENTRATION PPM	23.1	36.5	109.8	25.8
HC MASS GRAMS	3.27	4.12	3.74	2.97
CO MASS GRAMS	31.28	33.14	30.79	33.32
CO2 MASS GRAMS	1969.3	2996.9	7382.9	1963.2
NOX MASS GRAMS	13.13	21.01	64.24	14.73
FUEL KG (LB)	.643 (1.42)	.971 (2.14)	2.360 (5.20)	.642 (1.42)
KW HR (HP HR)	2.22 (2.98)	3.40 (4.56)	9.90 (13.27)	2.26 (3.03)
BSHC G/KW HR (G/HP HR)	1.47 (1.10)	1.21 (.90)	.38 (.28)	1.32 (.98)
BSCO G/KW HR (G/HP HR)	14.07 (10.50)	9.75 (7.27)	3.11 (2.32)	14.75 (11.00)
BSCO2 G/KW HR (G/HP HR)	886.20 (660.84)	881.34 (657.22)	746.09 (556.36)	868.88 (647.92)
BSNOX G/KW HR (G/HP HR)	5.91 (4.41)	6.18 (4.61)	6.49 (4.84)	6.52 (4.86)
BSFC KG/KW HR (LB/HP HR)	.289 (.476)	.286 (.469)	.238 (.392)	.284 (.467)

A-12

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES

GRAMS/TEST	17.60
G/KWHR(G/HPHR)	.99 (.74)
G/KG FUEL (G/LB FUEL)	3.81 (1.73)
FILTER EFF.	98.5

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.78 (23.84)
BSHC G/KW HR (G/HP HR)	.79 (.59)
BSCO G/KW HR (G/HP HR)	7.23 (5.39)
PSCO2 G/KW HR (G/HP HR)	805. (600.)
BSNOX G/KW HR (G/HP HR)	6.36 (4.74)
BSFC KG/KW HR (LB/HP HR)	.260 (.427)

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.C10-9 RUN1
DATE 7/19/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 740.16 MM HG(29.14 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-45. PCT , CVS-53. PCT
ABSOLUTE HUMIDITY 9.2 GM/KG(64.1 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	295.9	299.8	304.8	297.7
TOT. BLOWER RATE SCMM (SCFM)	59.63 (2105.6)	59.64 (2105.7)	59.64 (2105.9)	59.63 (2105.7)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.79)	.05 (1.79)	.05 (1.79)	.05 (1.79)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	294.3 (10393.)	298.2 (10531.)	303.2 (10707.)	296.1 (10457.)
HC SAMPLE METER/RANGE/PPM	32.9/11/ 33.	41.5/11/ 41.	36.5/11/ 37.	35.2/11/ 35.
HC BCKGRD METER/RANGE/PPM	7.0/ 1/ 7.	6.8/ 1/ 7.	6.3/ 1/ 6.	6.0/ 1/ 6.
CO SAMPLE METER/RANGE/PPM	79.8/13/ 79.	84.3/13/ 84.	87.0/13/ 87.	84.5/13/ 84.
CO BCKGRD METER/RANGE/PPM	1.4/13/ 1.	1.3/13/ 1.	1.7/13/ 2.	1.6/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	90.1/12/ .40	67.9/11/ .58	73.7/ 3/ 1.34	86.9/12/ .38
CO2 BCKGRD METER/RANGE/PCT	15.0/12/ .05	8.8/11/ .05	3.4/ 3/ .05	14.9/12/ .05
NOX SAMPLE METER/RANGE/PPM	84.4/ 1/ 25.	37.2/ 2/ 37.	36.1/ 3/ 108.	92.7/ 1/ 28.
NOX BCKGRD METER/RANGE/PPM	.9/ 1/ 0.	.4/ 2/ 0.	.1/ 3/ 0.	1.1/ 1/ 0.
DILUTION FACTOR	32.34	22.65	9.91	33.84
HC CONCENTRATION PPM	26.	35.	31.	29.
CO CONCENTRATION PPM	76.	81.	82.	81.
CO2 CONCENTRATION PCT	.35	.53	1.29	.33
NOX CONCENTRATION PPM	24.8	36.8	108.0	27.3
HC MASS GRAMS	4.44	6.02	5.39	5.02
CO MASS GRAMS	25.96	27.96	28.94	27.86
CO2 MASS GRAMS	1904.5	2895.9	7178.0	1814.3
NOX MASS GRAMS	13.99	21.00	62.65	15.44
FUEL KG (LB)	.621 (1.37)	.938 (2.07)	2.296 (5.06)	.594 (1.31)
KW HR (HP HR)	2.22 (2.98)	3.43 (4.60)	9.93 (13.32)	2.24 (3.01)
BSHC G/KW HR (G/HP HR)	2.00 (1.49)	1.75 (1.31)	.54 (.41)	2.24 (1.67)
BSCO G/KW HR (G/HP HR)	11.68 (8.71)	8.15 (6.08)	2.91 (2.17)	12.41 (9.25)
BSCO2 G/KW HR (G/HP HR)	857.02 (639.08)	844.24 (629.55)	722.67 (538.89)	808.30 (602.75)
BSNOX G/KW HR (G/HP HR)	6.29 (4.69)	6.12 (4.56)	6.31 (4.70)	6.88 (5.13)
BSFC KG/KW HR (LB/HP HR)	.280 (.460)	.274 (.450)	.231 (.380)	.265 (.435)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.83 (23.91)
BSHC G/KW HR (G/HP HR)	1.17 (.87)
BSCO G/KW HR (G/HP HR)	6.21 (4.63)
BSCO2 G/KW HR (G/HP HR)	774. (577.)
BSNOX G/KW HR (G/HP HR)	6.34 (4.73)
BSFC KG/KW HR (LB/HP HR)	.250 (.410)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	16.16
	G/KWHR(G/HPHR)	.91 (.68)
	G/KG FUEL (G/LB FUEL)	3.63 (1.65)
	FILTER EFF.	98.2

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

BAROMETER 740.66 MM HG(29.16 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

BAG RESULTS
BAG NUMBER
DESCRIPTION
TIME SECONDS
TOT. BLOWER RATE SCMM (SCFM)
TOT. 20X20 RATE SCMM (SCFM)
TOT. 90MM RATE SCMM (SCFM)
TOT. AUX. SAMPLE RATE SCMM (SCFM)
TOTAL FLOW STD. CU. METRES(SCF)

HC SAMPLE METER/RANGE/PPM
HC BCKGRD METER/RANGE/PPM
CO SAMPLE METER/RANGE/PPM
CO BCKGRD METER/RANGE/PPM
CO2 SAMPLE METER/RANGE/PCT
CO2 BCKGRD METER/RANGE/PCT
NOX SAMPLE METER/RANGE/PPM
NOX BCKGRD METER/RANGE/PPM

DILUTION FACTOR
HC CONCENTRATION PPM
CO CONCENTRATION PPM
CO2 CONCENTRATION PCT
NOX CONCENTRATION PPM

HC MASS GRAMS
CO MASS GRAMS
CO2 MASS GRAMS
NOX MASS GRAMS
FUEL KG (LB)
KW HR (HP HR)

BSHC G/KW HR (G/HP HR)
BSCO G/KW HR (G/HP HR)
BSCO2 G/KW HR (G/HP HR)
BSNOX G/KW HR (G/HP HR)
BSFC KG/KW HR (LB/HP HR)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.74 (23.79)
BSHC G/KW HR (G/HP HR)	1.02 (.76)
BSCO G/KW HR (G/HP HR)	8.62 (6.43)
BSCO2 G/KW HR (G/HP HR)	776. (579.)
BSNOX G/KW HR (G/HP HR)	5.25 (3.91)
BSFC KG/KW HR (LB/HP HR)	.251 (.413)

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

TEST NO.C10-10 RUN1
DATE 7/19/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

RELATIVE HUMIDITY , ENGINE-45. PCT , CVS-63. PCT
ABSOLUTE HUMIDITY 9.1 GM/KG(64.0 GRAINS/LB)

NOX HUMIDITY C.F. 1.0000

1	2	3	4
NYNF	LANF	LAF	NYNF
295.9	299.8	304.8	297.8
59.68 (2107.1)	59.69 (2107.7)	59.70 (2107.8)	59.67 (2106.9)
0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
.05 (1.69)	.05 (1.69)	.05 (1.69)	.05 (1.69)
0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
294.5 (10400.)	298.5 (10540.)	303.5 (10716.)	296.4 (10466.)
30.1/11/ 30.	35.2/11/ 35.	29.1/11/ 29.	33.8/11/ 34.
6.0/ 1/ 6.	6.0/ 1/ 6.	5.8/ 1/ 6.	5.8/ 1/ 6.
53.0/12/ 113.	51.8/12/ 110.	54.1/12/ 116.	56.2/12/ 122.
.6/12/ 1.	.9/12/ 2.	1.0/12/ 2.	.9/12/ 2.
88.2/12/ .39	68.0/11/ .58	72.9/ 3/ 1.32	87.7/12/ .39
14.1/12/ .05	8.1/11/ .05	3.1/ 3/ .05	13.5/12/ .05
68.2/ 1/ 20.	31.8/ 2/ 32.	89.1/ 2/ 89.	74.0/ 1/ 22.
1.0/ 1/ 0.	.3/ 2/ 0.	.6/ 2/ 1.	.5/ 1/ 0.
33.01	22.53	10.02	33.15
24.	29.	24.	28.
109.	105.	109.	117.
.35	.54	1.28	.34
20.0	31.5	88.6	21.9
4.12	5.07	4.17	4.82
37.44	36.60	38.59	40.24
1861.2	2927.7	7116.1	1868.2
11.27	17.99	51.40	12.40
.613 (1.35)	.952 (2.10)	2.280 (5.03)	.617 (1.36)
2.18 (2.93)	3.42 (4.59)	9.92 (13.30)	2.21 (2.97)
1.89 (1.41)	1.48 (1.11)	.42 (.31)	2.17 (1.62)
17.13 (12.78)	10.69 (7.97)	3.89 (2.90)	18.17 (13.55)
851.87 (635.24)	855.36 (637.84)	717.51 (535.04)	843.55 (629.03)
5.16 (3.84)	5.26 (3.92)	5.18 (3.86)	5.60 (4.17)
.281 (.461)	.278 (.457)	.230 (.378)	.279 (.458)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES

GRAMS/TEST	20.10
G/KWHR(G/HPHR)	1.13 (.85)
G/KG FUEL (G/LB FUEL)	4.51 (2.04)
FILTER EFF.	98.1

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-11 RUN1
DATE 7/20/84
TIME
DYNO NO. 4

DIESEL FM-597-F
BAG CART NO. 1

BAROMETER 740.16 MM HG(29.14 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-44. PCT , CVS-62. PCT
ABSOLUTE HUMIDITY 8.9 GM/KG(62.6 GRAINS/LB)

NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	295.9	299.9	304.8	297.8
TOT. BLOWER RATE SCMM (SCFM)	59.74 (2109.5)	59.75 (2109.6)	59.77 (2110.5)	59.75 (2109.9)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.68)	.05 (1.68)	.05 (1.68)	.05 (1.68)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	294.9 (10411.)	298.9 (10553.)	303.9 (10730.)	296.8 (10481.)
HC SAMPLE METER/RANGE/PPM	32.6/11/ 33.	40.0/11/ 40.	31.7/11/ 32.	37.7/11/ 38.
HC BCKGRD METER/RANGE/PPM	9.0/ 1/ 9.	6.8/ 1/ 7.	6.7/ 1/ 7.	6.1/ 1/ 6.
CO SAMPLE METER/RANGE/PPM	54.3/12/ 117.	54.9/12/ 118.	57.8/12/ 126.	58.1/12/ 127.
CO BCKGRD METER/RANGE/PPM	.2/12/ 0.	.2/12/ 0.	.1/12/ 0.	.6/12/ 1.
CO2 SAMPLE METER/RANGE/PCT	88.8/12/ .40	68.0/11/ .58	74.0/ 3/ 1.35	86.2/12/ .38
CO2 BCKGRD METER/RANGE/PCT	14.1/12/ .05	8.4/11/ .05	3.4/ 3/ .05	14.2/12/ .05
NOX SAMPLE METER/RANGE/PPM	65.9/ 1/ 20.	99.0/ 1/ 29.	90.7/ 2/ 91.	69.6/ 1/ 21.
NOX BCKGRD METER/RANGE/PPM	.4/ 1/ 0.	.4/ 1/ 0.	.4/ 2/ 0.	.3/ 1/ 0.
DILUTION FACTOR	32.67	22.48	9.84	33.82
HC CONCENTRATION PPM	24.	34.	26.	32.
CO CONCENTRATION PPM	113.	114.	120.	122.
CO2 CONCENTRATION PCT	.35	.53	1.30	.33
NOX CONCENTRATION PPM	19.5	29.3	90.3	20.6
HC MASS GRAMS	4.05	5.78	4.49	5.43
CO MASS GRAMS	38.83	39.73	42.39	42.16
CO2 MASS GRAMS	1882.7	2921.7	7227.9	1809.5
NOX MASS GRAMS	10.99	16.77	52.50	11.70
FUEL KG (LB)	.620 (1.37)	.952 (2.10)	2.317 (5.11)	.600 (1.32)
KW HR (HP HR)	2.19 (2.94)	3.39 (4.55)	9.90 (13.27)	2.22 (2.98)
BSHC G/KW HR (G/HP HR)	1.85 (1.38)	1.70 (1.27)	.45 (.34)	2.45 (1.82)
BSCO G/KW HP (G/HP HR)	17.71 (13.21)	11.71 (8.73)	4.28 (3.19)	18.97 (14.15)
BSCO2 G/KW HR (G/HP HR)	858.75 (640.37)	861.12 (642.14)	730.43 (544.68)	814.31 (607.23)
BSNOX G/KW HR (G/HP HR)	5.01 (3.74)	4.94 (3.69)	5.31 (3.96)	5.27 (3.93)
BSFC KG/KW HR (LB/HP HR)	.283 (.465)	.281 (.461)	.234 (.385)	.270 (.444)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.70 (23.74)
BSHC G/KW HR (G/HP HR)	1.12 (.83)
BSCO G/KW HR (G/HP HR)	9.21 (6.87)
BSCO2 G/KW HR (G/HP HR)	782. (583.)
BSNOX G/KW HR (G/HP HR)	5.19 (3.87)
BSFC KG/KW HR (LB/HP HR)	.254 (.417)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES GRAMS/TEST	21.89
G/KWHR(G/HPHP)	1.24 (.92)
G/KG FUEL (G/LB FUEL)	4.88 (2.21)
FILTER EFF.	98.9

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-12 RUN1
DATE 7/20/84
TIME
DYNO NO. 4

DIESEL FM-597-F
BAG CART NO. 1

BAROMETER 739.65 MM HG(29.12 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-45. PCT , CVS-62. PCT
ABSOLUTE HUMIDITY 9.2 GM/KG(64.1 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	295.9	299.9	305.0	297.9
TOT. BLOWER RATE SCMM (SCFM)	59.88 (2114.4)	59.89 (2114.9)	59.88 (2114.3)	59.88 (2114.5)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.68)	.05 (1.68)	.05 (1.68)	.05 (1.68)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	295.5 (10436.)	299.6 (10579.)	304.6 (10756.)	297.6 (10507.)
HC SAMPLE METER/RANGE/PPM	32.1/11/ 32.	37.5/11/ 38.	29.7/11/ 30.	37.0/11/ 37.
HC BCKGRD METER/RANGE/PPM	6.7/ 1/ 7.	7.0/ 1/ 7.	6.8/ 1/ 7.	7.0/ 1/ 7.
CO SAMPLE METER/RANGE/PPM	56.0/12/ 121.	54.3/12/ 117.	56.7/12/ 123.	58.1/12/ 127.
CO BCKGRD METER/RANGE/PPM	.5/12/ 1.	.4/12/ 1.	.6/12/ 1.	.4/12/ 1.
CO2 SAMPLE METER/RANGE/PCT	88.4/12/ .39	68.5/11/ .59	74.3/ 3/ 1.35	87.5/12/ .39
CO2 BCKGRD METER/RANGE/PCT	13.8/12/ .05	8.1/11/ .05	3.3/ 3/ .05	13.7/12/ .05
NOX SAMPLE METER/RANGE/PPM	68.7/ 1/ 20.	31.4/ 2/ 31.	90.9/ 2/ 91.	72.3/ 1/ 22.
NOX BCKGRD METER/RANGE/PPM	.5/ 1/ 0.	.2/ 2/ 0.	.5/ 2/ 1.	.4/ 1/ 0.
DILUTION FACTOR	32.83	22.27	9.80	33.18
HC CONCENTRATION PPM	26.	31.	24.	30.
CO CONCENTRATION PPM	117.	112.	116.	122.
CO2 CONCENTRATION PCT	.35	.54	1.31	.34
NOX CONCENTRATION PPM	20.3	31.2	90.5	21.4
HC MASS GRAMS	4.37	5.32	4.14	5.19
CO MASS GRAMS	40.20	39.19	41.22	42.38
CO2 MASS GRAMS	1879.8	2972.1	7287.8	1865.3
NOX MASS GRAMS	11.47	17.88	52.69	12.17
FUEL KG (LB)	.620 (1.37)	.967 (2.13)	2.335 (5.15)	.618 (1.36)
KW HR (HP HR)	2.19 (2.94)	3.37 (4.52)	9.93 (13.31)	2.21 (2.97)
BSHC G/KW HR (G/HP HR)	1.99 (1.49)	1.58 (1.18)	.42 (.31)	2.34 (1.75)
BSCO G/KW HR (G/HP HR)	18.34 (13.67)	11.63 (8.67)	4.15 (3.10)	19.14 (14.27)
BSCO2 G/KW HR (G/HP HR)	857.43 (639.39)	881.79 (657.55)	734.27 (547.54)	842.23 (628.05)
BSNOX G/KW HR (G/HP HR)	5.23 (3.90)	5.31 (3.96)	5.31 (3.96)	5.50 (4.10)
BSFC KG/KW HR (LB/HP HR)	.283 (.465)	.287 (.472)	.235 (.387)	.279 (.459)

TOTAL TEST RESULTS 4 BAGS

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

TOTAL KW HR (HP HR)	17.70 (23.74)
BSHC G/KW HR (G/HP HR)	1.07 (.80)
BSCO G/KW HR (G/HP HR)	9.21 (6.87)
BSCO2 G/KW HR (G/HP HR)	791. (590.)
BSNOX G/KW HR (G/HP HR)	5.32 (3.97)
BSFC KG/KW HR (LB/HP HR)	.257 (.422)

90MM PARTICULATE RATES		
	GRAMS/TEST	21.25
	G/KWHR(G/HPHR)	1.20 (.90)
	G/KG FUEL (G/LB FUEL)	4.68 (2.12)
	FILTER EFF.	99.0

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

BAROMETER 738.89 MM HG(29.09 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

TEST NO.10-13 RUN1
DATE 7/20/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

RELATIVE HUMIDITY , ENGINE-44. PCT , CVS-53. PCT
ABSOLUTE HUMIDITY 9.0 GM/KG(62.7 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	296.0	299.9	304.9	297.9
TOT. BLOWER RATE SCMM (SCFM)	59.51 (2101.2)	59.51 (2101.4)	59.53 (2102.0)	59.51 (2101.3)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.71)	.05 (1.71)	.05 (1.71)	.05 (1.71)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	293.8 (10374.)	297.7 (10512.)	302.7 (10690.)	295.7 (10442.)
HC SAMPLE METER/RANGE/PPM	31.5/11/ 32.	36.7/11/ 37.	30.0/11/ 30.	36.2/11/ 36.
HC BCKGRD METER/RANGE/PPM	6.7/ 1/ 7.	6.6/ 1/ 7.	6.3/ 1/ 6.	6.4/ 1/ 6.
CO SAMPLE METER/RANGE/PPM	48.0/12/ 101.	51.8/12/ 110.	56.5/12/ 122.	48.5/12/ 102.
CO BCKGRD METER/RANGE/PPM	1.1/12/ 2.	.6/12/ 1.	.6/12/ 1.	.6/12/ 1.
CO2 SAMPLE METER/RANGE/PCT	88.8/12/ .40	67.6/11/ .58	74.1/ 3/ 1.35	87.1/12/ .39
CO2 BCKGRD METER/PANGE/PCT	12.8/12/ .04	7.6/11/ .04	3.3/ 3/ .05	12.8/12/ .04
NOX SAMPLE METER/RANGE/PPM	76.7/ 1/ 23.	31.8/ 2/ 32.	91.9/ 2/ 92.	83.3/ 1/ 25.
NOX BCKGRD METER/RANGE/PPM	.8/ 1/ 0.	.4/ 2/ 0.	.5/ 2/ 1.	.7/ 1/ 0.
DILUTION FACTOR	32.80	22.71	9.83	33.58
HC CONCENTRATION PPM	25.	30.	24.	30.
CO CONCENTRATION PPM	97.	106.	116.	99.
CO2 CONCENTRATION PCT	.35	.53	1.30	.34
NOX CONCENTRATION PPM	22.6	31.4	91.5	24.6
HC MASS GRAMS	4.24	5.22	4.25	5.11
CO MASS GRAMS	33.02	36.82	40.92	33.96
CO2 MASS GRAMS	1900.4	2909.5	7220.0	1857.9
NOX MASS GRAMS	12.69	17.89	52.95	13.90
FUEL KG (LB)	.623 (1.37)	.946 (2.09)	2.314 (5.10)	.611 (1.35)
KW HR (HP HR)	2.21 (2.96)	3.40 (4.56)	9.89 (13.26)	2.24 (3.00)
BSHC G/KW HR (G/HP HR)	1.92 (1.43)	1.54 (1.15)	.43 (.32)	2.29 (1.70)
BSCO G/KW HR (G/HP HR)	14.96 (11.16)	10.83 (8.07)	4.14 (3.09)	15.18 (11.32)
BSCO2 G/KW HR (G/HP HR)	860.95 (642.01)	855.64 (638.05)	730.18 (544.50)	830.49 (619.29)
BSNOX G/KW HR (G/HP HR)	5.75 (4.29)	5.26 (3.92)	5.35 (3.99)	6.21 (4.63)
BSFC KG/KW HR (LB/HP HR)	.282 (.464)	.278 (.457)	.234 (.385)	.273 (.449)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.73 (23.78)
BSHC G/KW HR (G/HP HR)	1.06 (.79)
BSCO G/KW HR (G/HP HR)	8.16 (6.09)
BSCO2 G/KW HR (G/HP HR)	783. (584.)
BSNOX G/KW HR (G/HP HR)	5.49 (4.10)
BSFC KG/KW HR (LB/HP HR)	.253 (.417)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	
GRAMS/TEST	19.66
G/KWHR(G/HPHR)	1.11 (.83)
G/KG FUEL (G/LB FUEL)	4.37 (1.98)
FILTER EFF.	99.0

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-14 RUN1
DATE 7/24/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 741.43 MM HG(29.19 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-45. PCT , CVS-52. PCT
ABSOLUTE HUMIDITY 9.1 GM/KG(63.9 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	295.9	299.8	304.9	297.8
TOT. BLOWER RATE SCMM (SCFM)	59.87 (2114.1)	59.90 (2115.0)	59.86 (2113.7)	59.88 (2114.2)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.71)	.05 (1.71)	.05 (1.71)	.05 (1.71)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	295.5 (10435.)	299.5 (10577.)	304.4 (10750.)	297.4 (10502.)
HC SAMPLE METER/RANGE/PPM	36.7/11/ 37.	42.2/11/ 42.	35.6/11/ 36.	41.5/11/ 42.
HC BCKGRD METER/RANGE/PPM	10.1/ 1/ 10.	9.9/ 1/ 10.	9.1/ 1/ 9.	8.9/ 1/ 9.
CO SAMPLE METER/RANGE/PPM	50.9/12/ 108.	55.5/12/ 120.	58.0/12/ 126.	59.3/12/ 130.
CO BCKGRD METER/RANGE/PPM	1.3/12/ 2.	.8/12/ 1.	.8/12/ 1.	1.1/12/ 2.
CO2 SAMPLE METER/RANGE/PCT	88.6/12/ .39	66.8/11/ .57	72.2/ 3/ 1.31	90.6/12/ .41
CO2 BCKGRD METER/RANGE/PCT	13.2/12/ .04	8.6/11/ .05	3.0/ 3/ .05	13.8/12/ .05
NOX SAMPLE METER/RANGE/PPM	63.7/ 1/ 19.	95.7/ 1/ 28.	84.0/ 2/ 84.	74.9/ 1/ 22.
NOX BCKGRD METER/RANGE/PPM	1.1/ 1/ 0.	1.2/ 1/ 0.	.3/ 2/ 0.	.9/ 1/ 0.
DILUTION FACTOR	32.80	23.02	10.12	31.67
HC CONCENTRATION PPM	27.	33.	27.	33.
CO CONCENTRATION PPM	103.	115.	120.	125.
CO2 CONCENTRATION PCT	.35	.52	1.27	.36
NOX CONCENTRATION PPM	18.6	28.1	83.7	22.0
HC MASS GRAMS	4.59	5.66	4.80	5.65
CO MASS GRAMS	35.50	40.12	42.41	43.13
CO2 MASS GRAMS	1897.4	2842.3	7066.0	1964.1
NOX MASS GRAMS	10.53	16.11	48.75	12.53
FUEL KG (LB)	.624 (1.38)	.927 (2.04)	2.266 (5.00)	.650 (1.43)
KW HR (HP HR)	2.23 (2.99)	3.40 (4.56)	9.56 (12.82)	2.33 (3.13)
BSHC G/KW HR (G/HP HR)	2.06 (1.54)	1.66 (1.24)	.50 (.37)	2.42 (1.80)
BSCO G/KW HR (G/HP HR)	15.92 (11.87)	11.80 (8.80)	4.44 (3.31)	18.48 (13.78)
BSCO2 G/KW HR (G/HP HR)	850.98 (634.58)	835.89 (623.32)	739.13 (551.17)	841.51 (627.52)
BSNOX G/KW HR (G/HP HR)	4.72 (3.52)	4.74 (3.53)	5.10 (3.80)	5.37 (4.00)
BSFC KG/KW HR (LB/HP HR)	.280 (.460)	.273 (.448)	.237 (.390)	.278 (.458)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.52 (23.50)
BSHC G/KW HR (G/HP HR)	1.18 (.88)
BSCO G/KW HR (G/HP HR)	9.20 (6.86)
BSCO2 G/KW HR (G/HP HR)	786. (586.)
BSNOX G/KW HR (G/HP HR)	5.02 (3.74)
BSFC KG/KW HR (LB/HP HR)	.255 (.419)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	24.65
	G/KWHR(G/HPHR)	1.41 (1.05)
	G/KG FUEL (G/LB FUEL)	5.52 (2.50)
	FILTER EFF.	98.6

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-15 RUN1
DATE 7/27/84
TIME
DYNO NO. 4

DIESEL FM-597-F
BAG CART NO. 1

BAROMETER 742.95 MM HG(29.25 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-44. PCT , CVS-59. PCT
ABSOLUTE HUMIDITY 8.9 GM/KG(62.4 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER				
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	295.9	299.8	304.9	306.8
TOT. BLOWER RATE SCMM (SCFM)	59.83 (2112.7)	59.84 (2112.9)	59.83 (2112.7)	59.83 (2112.4)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.04 (1.37)	.04 (1.37)	.04 (1.37)	.04 (1.37)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	295.3 (10426.)	299.2 (10564.)	304.2 (10743.)	306.1 (10809.)
HC SAMPLE METER/RANGE/PPM	37.4/11/ 37.	40.8/11/ 41.	28.1/11/ 28.	33.0/11/ 33.
HC BCKGRD METER/RANGE/PPM	7.4/ 1/ 7.	7.1/ 1/ 7.	6.8/ 1/ 7.	6.7/ 1/ 7.
CO SAMPLE METER/RANGE/PPM	81.2/12/ 193.	92.0/12/ 228.	80.1/11/ 363.	98.2/12/ 250.
CO BCKGRD METER/RANGE/PPM	.6/12/ 1.	.9/12/ 2.	.4/11/ 1.	.7/12/ 1.
CO2 SAMPLE METER/RANGE/PCT	81.0/12/ .35	65.1/11/ .55	75.1/ 3/ 1.37	86.1/12/ .38
CO2 BCKGRD METER/RANGE/PCT	14.7/12/ .05	8.6/11/ .05	3.8/ 3/ .06	14.3/12/ .05
NOX SAMPLE METER/RANGE/PPM	37.3/ 1/ 11.	54.6/ 1/ 16.	52.3/ 2/ 52.	43.7/ 1/ 13.
NOX BCKGRD METER/RANGE/PPM	.9/ 1/ 0.	1.0/ 1/ 0.	.1/ 2/ 0.	.3/ 1/ 0.
DILUTION FACTOR	35.93	23.42	9.53	32.91
HC CONCENTRATION PPM	30.	34.	22.	27.
CO CONCENTRATION PPM	187.	220.	346.	242.
CO2 CONCENTRATION PCT	.30	.50	1.32	.33
NOX CONCENTRATION PPM	10.8	16.0	52.2	12.9
HC MASS GRAMS	5.15	5.87	3.87	4.69
CO MASS GRAMS	64.20	76.52	122.41	86.13
CO2 MASS GRAMS	1629.5	2728.6	7332.4	1861.1
NOX MASS GRAMS	6.12	9.13	30.38	7.56
FUEL KG (LB)	.554 (1.22)	.909 (2.00)	2.390 (5.27)	.638 (1.41)
KW HR (HP HR)	2.35 (3.15)	3.48 (4.67)	10.05 (13.48)	2.34 (3.14)
BSHC G/KW HR (G/HP HR)	2.19 (1.63)	1.69 (1.26)	.39 (.29)	2.00 (1.49)
BSCO G/KW HR (G/HP HR)	27.33 (20.38)	21.97 (16.39)	12.18 (9.08)	36.79 (27.43)
BSCO2 G/KW HR (G/HP HR)	693.70 (517.29)	783.53 (584.28)	729.44 (543.95)	794.85 (592.72)
BSNOX G/KW HR (G/HP HR)	2.60 (1.94)	2.62 (1.96)	3.02 (2.25)	3.23 (2.41)
BSFC KG/KW HR (LB/HP HR)	.236 (.388)	.261 (.429)	.238 (.391)	.272 (.448)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	18.22 (24.44)
BSHC G/KW HR (G/HP HR)	1.07 (.80)
BSCO G/KW HR (G/HP HR)	19.16 (14.29)
BSCO2 G/KW HR (G/HP HR)	744. (554.)
BSNOX G/KW HR (G/HP HR)	2.92 (2.18)
BSFC KG/KW HR (LB/HP HR)	.246 (.405)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	51.83
	G/KWHR(G/HPHR)	2.84 (2.12)
	G/KG FUEL (G/LB FUEL)	11.54 (5.23)
	FILTER EFF.	99.4

ENGINE EMISSION RESULTS
H-TRANS

PROJECT NO. 03-7338-015

TEST NO.10-16 RUN1
DATE 7/30/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

RELATIVE HUMIDITY , ENGINE-48. PCT , CVS-44. PCT
ABSOLUTE HUMIDITY 9.7 GM/KG(68.2 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	295.9	299.9	304.9	310.8
TOT. BLOWER RATE SCMM (SCFM)	59.75 (2109.6)	59.77 (2110.5)	59.77 (2110.3)	59.76 (2110.2)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.62)	.05 (1.62)	.05 (1.62)	.05 (1.62)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	294.9 (10412.)	299.0 (10557.)	303.9 (10732.)	309.8 (10939.)
HC SAMPLE METER/RANGE/PPM	32.0/11/ 32.	38.1/11/ 38.	28.4/11/ 28.	31.6/11/ 32.
HC BCKGRD METER/RANGE/PPM	6.6/ 1/ 7.	6.3/ 1/ 6.	6.2/ 1/ 6.	6.0/ 1/ 6.
CO SAMPLE METER/RANGE/PPM	66.7/12/ 150.	71.4/12/ 163.	77.5/12/ 181.	65.4/12/ 146.
CO BCKGRD METER/RANGE/PPM	.8/12/ 1.	.7/12/ 1.	.8/12/ 1.	.9/12/ 2.
CO2 SAMPLE METER/RANGE/PCT	88.0/12/ .39	67.5/11/ .57	74.6/ 3/ 1.36	85.5/12/ .38
CO2 BCKGRD METER/RANGE/PCT	12.5/12/ .04	7.3/11/ .04	2.5/ 3/ .04	12.8/12/ .04
NOX SAMPLE METER/RANGE/PPM	56.7/ 1/ 17.	84.9/ 1/ 25.	77.2/ 2/ 77.	58.6/ 1/ 17.
NOX BCKGRD METER/RANGE/PPM	.5/ 1/ 0.	.8/ 1/ 0.	.3/ 2/ 0.	.7/ 1/ 0.
DILUTION FACTOR	32.79	22.55	9.72	34.05
HC CONCENTRATION PPM	26.	32.	23.	26.
CO CONCENTRATION PPM	145.	158.	173.	141.
CO2 CONCENTRATION PCT	.35	.53	1.32	.33
NOX CONCENTRATION PPM	16.7	25.0	76.9	17.2
HC MASS GRAMS	4.35	5.53	4.01	4.60
CO MASS GRAMS	49.84	54.96	61.13	51.03
CO2 MASS GRAMS	1887.1	2925.0	7367.6	1893.3
NOX MASS GRAMS	9.43	14.31	44.72	10.21
FUEL KG (LB)	.628 (1.38)	.960 (2.12)	2.371 (5.23)	.630 (1.39)
KW HR (HP HR)	2.25 (3.02)	3.46 (4.64)	10.04 (13.47)	2.27 (3.04)
BSHC G/KW HR (G/HP HR)	1.93 (1.44)	1.60 (1.19)	.40 (.30)	2.03 (1.51)
BSCO G/KW HR (G/HP HR)	22.13 (16.50)	15.88 (11.85)	6.09 (4.54)	22.51 (16.79)
BSCO2 G/KW HR (G/HP HR)	837.96 (624.87)	845.36 (630.38)	733.49 (546.96)	835.17 (622.79)
BSNOX G/KW HR (G/HP HR)	4.19 (3.12)	4.14 (3.08)	4.45 (3.32)	4.50 (3.36)
BSFC KG/KW HR (LB/HP HR)	.279 (.458)	.278 (.456)	.236 (.388)	.278 (.457)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES

GRAMS/TEST	31.79
G/KWHR(G/HPHR)	1.76 (1.32)
G/KG FUEL (G/LB FUEL)	6.93 (3.14)
FILTER EFF.	98.7

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	18.02 (24.17)
BSHC G/KW HR (G/HP HR)	1.03 (.76)
BSCO G/KW HR (G/HP HR)	12.04 (8.98)
BSCO2 G/KW HR (G/HP HR)	781. (582.)
BSNOX G/KW HR (G/HP HR)	4.36 (3.25)
BSFC KG/KW HR (LB/HP HR)	.255 (.419)

ENGINE EMISSION RESULTS
C-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-17 RUN1
DATE 7/31/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 741.93 MM HG(29.21 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-47. PCT , CVS-56. PCT
ABSOLUTE HUMIDITY 9.5 GM/KG(66.8 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER				
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	295.9	300.0	304.9	313.8
TOT. BLOWER RATE SCMM (SCFM)	59.60 (2104.6)	59.56 (2103.2)	59.60 (2104.5)	59.59 (2104.2)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.04 (1.57)	.04 (1.57)	.04 (1.57)	.04 (1.57)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	294.2 (10387.)	298.0 (10524.)	303.1 (10703.)	311.9 (11013.)
HC SAMPLE METER/RANGE/PPM	41.7/11/ 42.	45.2/11/ 45.	55.5/11/ 56.	39.8/11/ 40.
HC BCKGRD METER/RANGE/PPM	5.8/ 1/ 6.	5.7/ 1/ 6.	5.6/ 1/ 6.	5.5/ 1/ 6.
CO SAMPLE METER/RANGE/PPM	79.4/13/ 78.	65.2/12/ 146.	84.2/12/ 202.	56.3/12/ 122.
CO BCKGRD METER/RANGE/PPM	2.9/13/ 3.	1.3/12/ 2.	1.5/12/ 3.	1.3/12/ 2.
CO2 SAMPLE METER/RANGE/PCT	92.2/12/ .42	70.7/11/ .61	76.7/ 3/ 1.40	88.0/12/ .39
CO2 BCKGRD METER/RANGE/PCT	13.0/12/ .04	7.5/11/ .04	2.6/ 3/ .04	12.2/12/ .04
NOX SAMPLE METER/RANGE/PPM	58.8/ 1/ 17.	84.7/ 1/ 25.	78.6/ 2/ 79.	69.7/ 1/ 21.
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ 0.	.9/ 1/ 0.	.3/ 2/ 0.	.9/ 1/ 0.
DILUTION FACTOR	31.31	21.19	9.39	32.96
HC CONCENTRATION PPM	36.	40.	51.	34.
CO CONCENTRATION PPM	74.	139.	191.	116.
CO2 CONCENTRATION PCT	.37	.57	1.37	.35
NOX CONCENTRATION PPM	17.3	24.9	78.3	20.5
HC MASS GRAMS	6.11	6.84	8.83	6.20
CO MASS GRAMS	25.33	48.25	67.30	42.27
CO2 MASS GRAMS	2010.4	3124.4	7580.1	2002.0
NOX MASS GRAMS	9.73	14.22	45.41	12.21
FUEL KG (LB)	.656 (1.45)	1.022 (2.25)	2.446 (5.39)	.662 (1.46)
KW HR (HP HR)	2.07 (2.78)	3.36 (4.50)	10.12 (13.57)	2.42 (3.24)
BSHC G/KW HR (G/HP HR)	2.95 (2.20)	2.04 (1.52)	.87 (.65)	2.57 (1.91)
BSCO G/KW HR (G/HP HR)	12.22 (9.11)	14.38 (10.72)	6.65 (4.96)	17.50 (13.05)
BSCO2 G/KW HR (G/HP HR)	969.78 (723.17)	931.09 (694.32)	749.09 (558.60)	828.61 (617.89)
BSNOX G/KW HR (G/HP HR)	4.69 (3.50)	4.24 (3.16)	4.49 (3.35)	5.05 (3.77)
BSFC KG/KW HR (LB/HP HR)	.317 (.520)	.304 (.500)	.242 (.397)	.274 (.450)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.96 (24.09)
BSHC G/KW HR (G/HP HR)	1.56 (1.16)
BSCO G/KW HR (G/HP HR)	10.20 (7.60)
BSCO2 G/KW HR (G/HP HR)	819. (611.)
BSNOX G/KW HR (G/HP HR)	4.54 (3.39)
BSFC KG/KW HR (LB/HP HR)	.266 (.438)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	30.96
	G/KWHR(G/HPHR)	1.72 (1.29)
	G/KG FUEL (G/LB FUEL)	6.47 (2.93)
	FILTER EFF.	98.4

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-17 RUN1
DATE 7/31/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 742.19 MM HG(29.22 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-47. PCT , CVS-57. PCT
ABSOLUTE HUMIDITY 9.5 GM/KG(66.8 GRAINS/LB)

NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	296.0	300.0	305.0	310.8
TOT. BLOWER RATE SCMM (SCFM)	59.62 (2105.3)	59.62 (2105.1)	59.63 (2105.6)	59.63 (2105.6)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.65)	.05 (1.65)	.05 (1.65)	.05 (1.65)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	294.4 (10394.)	298.3 (10534.)	303.4 (10712.)	309.1 (10915.)
HC SAMPLE METER/RANGE/PPM	31.2/11/ 31.	36.2/11/ 36.	28.7/11/ 29.	32.3/11/ 32.
HC BCKGRD METER/RANGE/PPM	7.0/ 1/ 7.	6.8/ 1/ 7.	6.4/ 1/ 6.	6.2/ 1/ 6.
CO SAMPLE METER/RANGE/PPM	50.8/12/ 108.	55.6/12/ 120.	69.4/12/ 157.	53.8/12/ 115.
CO BCKGRD METER/RANGE/PPM	1.1/12/ 2.	1.3/12/ 2.	1.3/12/ 2.	1.6/12/ 3.
CO2 SAMPLE METER/RANGE/PCT	82.4/12/ .36	65.3/11/ .55	74.7/ 3/ 1.36	86.8/12/ .38
CO2 BCKGRD METER/RANGE/PCT	11.7/12/ .04	7.0/11/ .04	3.1/ 3/ .05	12.4/12/ .04
NOX SAMPLE METER/RANGE/PPM	65.3/ 1/ 19.	91.4/ 1/ 27.	86.0/ 2/ 86.	72.9/ 1/ 22.
NOX BCKGRD METER/RANGE/PPM	.9/ 1/ 0.	1.0/ 1/ 0.	.3/ 2/ 0.	.4/ 1/ 0.
DILUTION FACTOR	36.03	23.77	9.72	33.66
HC CONCENTRATION PPM	24.	30.	23.	26.
CO CONCENTRATION PPM	103.	114.	148.	110.
CO2 CONCENTRATION PCT	.32	.51	1.32	.34
NOX CONCENTRATION PPM	19.2	26.9	85.7	21.6
HC MASS GRAMS	4.15	5.11	4.02	4.69
CO MASS GRAMS	35.37	39.70	52.40	39.45
CO2 MASS GRAMS	1723.4	2784.5	7319.1	1940.0
NOX MASS GRAMS	10.79	15.35	49.74	12.75
FUEL KG (LB)	.568 (1.25)	.908 (2.00)	2.351 (5.18)	.639 (1.41)
KW HR (HP HR)	2.46 (3.30)	3.56 (4.78)	10.16 (13.62)	2.31 (3.10)
BSHC G/KW HR (G/HP HR)	1.68 (1.26)	1.43 (1.07)	.40 (.29)	2.03 (1.51)
BSCO G/KW HR (G/HP HR)	14.38 (10.72)	11.14 (8.30)	5.16 (3.85)	17.07 (12.73)
BSCO2 G/KW HR (G/HP HR)	700.34 (522.24)	781.20 (582.54)	720.63 (537.38)	839.24 (625.82)
BSNOX G/KW HR (G/HP HR)	4.38 (3.27)	4.31 (3.21)	4.90 (3.65)	5.52 (4.11)
BSFC KG/KW HR (LB/HP HR)	.231 (.380)	.255 (.419)	.231 (.381)	.277 (.455)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	18.49 (24.80)
BSHC G/KW HR (G/HP HR)	.97 (.72)
BSCO G/KW HR (G/HP HR)	9.03 (6.73)
BSCO2 G/KW HR (G/HP HR)	744. (555.)
BSNOX G/KW HR (G/HP HR)	4.79 (3.57)
BSFC KG/KW HR (LB/HP HR)	.242 (.397)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	24.22
	G/KWHR(G/HPHR)	1.31 (.98)
	G/KG FUEL (G/LB FUEL)	5.42 (2.46)
	FILTER EFF.	98.4

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-17 RUN2
DATE 7/31/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 741.93 MM HG(29.21 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-47. PCT , CVS-53. PCT
ABSOLUTE HUMIDITY 9.5 GM/KG(66.8 GRAINS/LB)

NOX HUMIDITY C.F. 1.0000

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	296.0	300.1	305.0	311.8
TOT. BLOWER RATE SCMM (SCFM)	59.50 (2100.9)	59.50 (2101.0)	59.51 (2101.3)	59.50 (2100.9)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.73)	.05 (1.73)	.05 (1.73)	.05 (1.73)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	293.8 (10373.)	297.9 (10517.)	302.8 (10690.)	309.4 (10926.)
HC SAMPLE METER/RANGE/PPM	30.6/11/ 31.	36.5/11/ 37.	28.4/11/ 28.	32.7/11/ 33.
HC BCKGRD METER/RANGE/PPM	6.5/ 1/ 7.	6.4/ 1/ 6.	6.0/ 1/ 6.	5.8/ 1/ 6.
CO SAMPLE METER/RANGE/PPM	48.3/12/ 102.	54.8/12/ 118.	67.2/12/ 151.	52.4/12/ 112.
CO BCKGRD METER/RANGE/PPM	.5/12/ 1.	.6/12/ 1.	.7/12/ 1.	.8/12/ 1.
CO2 SAMPLE METER/RANGE/PCT	86.4/12/ .38	67.2/11/ .57	76.0/ 3/ 1.39	87.7/12/ .39
CO2 BCKGRD METEP/RANGE/PCT	13.9/12/ .05	8.8/11/ .05	3.4/ 3/ .05	13.5/12/ .05
NOX SAMPLE METER/RANGE/PPM	67.0/ 1/ 20.	95.4/ 1/ 28.	88.5/ 2/ 89.	73.8/ 1/ 22.
NOX BCKGRD METER/RANGE/PPM	.5/ 1/ 0.	.5/ 1/ 0.	.3/ 2/ 0.	.3/ 1/ 0.
DILUTION FACTOR	33.98	22.86	9.54	33.24
HC CONCENTRATION PPM	24.	30.	23.	27.
CO CONCENTRATION PPM	98.	114.	143.	108.
CO2 CONCENTRATION PCT	.34	.52	1.34	.34
NOX CONCENTRATION PPM	19.8	28.2	88.2	21.9
HC MASS GRAMS	4.12	5.22	4.02	4.82
CO MASS GRAMS	33.64	39.40	50.57	38.81
CO2 MASS GRAMS	1802.9	2846.2	7429.8	1950.5
NOX MASS GRAMS	11.12	16.08	51.08	12.94
FUEL KG (LB)	.593 (1.31)	.927 (2.04)	2.385 (5.26)	.643 (1.42)
KW HR (HP HR)	2.42 (3.25)	3.45 (4.63)	10.10 (13.54)	2.30 (3.09)
BSHC G/KW HR (G/HP HR)	1.70 (1.27)	1.51 (1.13)	.40 (.30)	2.09 (1.56)
BSCO G/KW HR (G/HP HR)	13.88 (10.35)	11.41 (8.51)	5.01 (3.73)	16.84 (12.56)
BSCO2 G/KW HR (G/HP HR)	743.90 (554.73)	824.35 (614.72)	735.86 (548.73)	846.49 (631.23)
BSNOX G/KW HR (G/HP HR)	4.59 (3.42)	4.66 (3.47)	5.06 (3.77)	5.62 (4.19)
BSFC KG/KW HR (LB/HP HR)	.244 (.402)	.269 (.442)	.236 (.388)	.279 (.458)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	18.28 (24.51)
BSHC G/KW HR (G/HP HR)	.99 (.74)
BSCO G/KW HR (G/HP HR)	8.89 (6.63)
BSCO2 G/KW HR (G/HP HR)	768. (572.)
BSNOX G/KW HR (G/HP HR)	4.99 (3.72)
BSFC KG/KW HR (LB/HP HR)	.249 (.409)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	23.70
	G/KWHR(G/HPHR)	1.30 (.97)
	G/KG FUEL (G/LB FUEL)	5.21 (2.36)
	FILTER EFF.	98.8

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

BAROMETER 741.68 MM HG(29.20 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

BAG RESULTS
BAG NUMBER
DESCRIPTION
TIME SECONDS
TOT. BLOWER RATE SCMM (SCFM)
TOT. 20X20 RATE SCMM (SCFM)
TOT. 90MM RATE SCMM (SCFM)
TOT. AUX. SAMPLE RATE SCMM (SCFM)
TOTAL FLOW STD. CU. METRES(SCF)

HC SAMPLE METER/RANGE/PPM
HC BCKGRD METER/RANGE/PPM
CO SAMPLE METER/RANGE/PPM
CO BCKGRD METER/RANGE/PPM
CO2 SAMPLE METER/RANGE/PCT
CO2 BCKGRD METER/RANGE/PCT
NOX SAMPLE METER/RANGE/PPM
NOX BCKGRD METER/RANGE/PPM

DILUTION FACTOR
HC CONCENTRATION PPM
CO CONCENTRATION PPM
CO2 CONCENTRATION PCT
NOX CONCENTRATION PPM

HC MASS GRAMS
CO MASS GRAMS
CO2 MASS GRAMS
NOX MASS GRAMS
FUEL KG (LB)
KW HR (HP HR)

BSHC G/KW HR (G/HP HR)
BSCO G/KW HR (G/HP HR)
BSCO2 G/KW HR (G/HP HR)
BSNOX G/KW HR (G/HP HR)
BSFC KG/KW HR (LB/HP HR)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	18.12 (24.30)
BSHC G/KW HR (G/HP HR)	1.04 (.78)
BSCO G/KW HR (G/HP HR)	12.19 (9.09)
BSCO2 G/KW HR (G/HP HR)	753. (562.)
BSNOX G/KW HR (G/HP HR)	4.28 (3.19)
BSFC KG/KW HR (LB/HP HR)	.246 (.404)

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

TEST NO.10-18 RUN1
DATE 8/ 1/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

RELATIVE HUMIDITY , ENGINE-45. PCT , CVS-57. PCT
ABSOLUTE HUMIDITY 9.1 GM/KG(63.9 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

1	2	3	4
NYNF	LANF	LAF	NYNF
296.0	299.9	305.0	310.9
59.47 (2099.8)	59.49 (2100.7)	59.47 (2099.8)	59.46 (2099.7)
0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
.04 (1.53)	.04 (1.53)	.04 (1.53)	.04 (1.53)
0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
293.6 (10366.)	297.6 (10508.)	302.5 (10682.)	308.3 (10888.)
31.4/11/ 31.	37.9/11/ 38.	28.5/11/ 28.	35.0/11/ 35.
6.5/ 1/ 7.	6.2/ 1/ 6.	6.2/ 1/ 6.	6.1/ 1/ 6.
73.9/12/ 171.	70.4/12/ 160.	76.3/12/ 178.	65.7/12/ 147.
.5/12/ 1.	.5/12/ 1.	.4/12/ 1.	.4/12/ 1.
89.8/12/ .40	67.6/11/ .58	72.0/ 3/ 1.30	86.1/12/ .38
14.4/12/ .05	8.6/11/ .05	3.2/ 3/ .05	13.6/12/ .05
57.8/ 1/ 17.	83.4/ 1/ 25.	76.0/ 2/ 76.	58.4/ 1/ 17.
.4/ 1/ 0.	.7/ 1/ 0.	.3/ 2/ 0.	.7/ 1/ 0.
31.81	22.52	10.11	33.72
25.	32.	23.	29.
165.	155.	169.	143.
.35	.53	1.26	.33
17.1	24.6	75.7	17.2
4.25	5.49	3.99	5.17
56.49	53.62	59.65	51.19
1901.4	2876.4	6983.0	1888.4
9.59	14.01	43.81	10.13
.635 (1.40)	.944 (2.08)	2.248 (4.96)	.629 (1.39)
2.33 (3.12)	3.46 (4.64)	10.02 (13.44)	2.31 (3.10)
1.83 (1.36)	1.59 (1.18)	.40 (.30)	2.24 (1.67)
24.28 (18.10)	15.50 (11.56)	5.95 (4.44)	22.14 (16.51)
817.24 (609.42)	831.31 (619.91)	696.75 (519.57)	816.90 (609.16)
4.12 (3.07)	4.05 (3.02)	4.37 (3.26)	4.38 (3.27)
.273 (.449)	.273 (.449)	.224 (.369)	.272 (.448)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	31.28
	G/KWHR(G/HPHR)	1.73 (1.29)
	G/KG FUEL (G/LB FUEL)	7.02 (3.18)
	FILTER EFF.	98.8

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-18 RUN2
DATE 8/ 1/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 741.68 MM HG(29.20 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-45. PCT , CVS-54. PCT
ABSOLUTE HUMIDITY 9.1 GM/KG(63.9 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	295.9	299.9	304.9	306.9
TOT. BLOWER RATE SCMM (SCFM)	59.48 (2100.2)	59.47 (2100.0)	59.49 (2100.5)	59.48 (2100.2)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.64)	.05 (1.64)	.05 (1.64)	.05 (1.64)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	293.6 (10365.)	297.5 (10504.)	302.5 (10682.)	304.5 (10751.)
HC SAMPLE METER/RANGE/PPM	31.4/11/ 31.	39.4/11/ 39.	29.9/11/ 30.	35.1/11/ 35.
HC BCKGRD METER/RANGE/PPM	7.0/ 1/ 7.	6.9/ 1/ 7.	6.4/ 1/ 6.	6.1/ 1/ 6.
CO SAMPLE METER/RANGE/PPM	65.2/12/ 146.	67.3/12/ 152.	77.9/12/ 183.	65.5/12/ 147.
CO BCKGRD METER/RANGE/PPM	.4/12/ 1.	.4/12/ 1.	.5/12/ 1.	.5/12/ 1.
CO2 SAMPLE METER/RANGE/PCT	86.9/12/ .38	66.8/11/ .57	74.9/ 3/ 1.36	84.4/12/ .37
CO2 BCKGRD METER/RANGE/PCT	13.8/12/ .05	8.0/11/ .05	3.4/ 3/ .05	13.3/12/ .05
NOX SAMPLE METER/RANGE/PPM	56.6/ 1/ 17.	85.7/ 1/ 25.	81.0/ 2/ 81.	59.9/ 1/ 18.
NOX BCKGRD METER/RANGE/PPM	.6/ 1/ 0.	.5/ 1/ 0.	.2/ 2/ 0.	.3/ 1/ 0.
DILUTION FACTOR	33.37	22.91	9.68	34.58
HC CONCENTRATION PPM	25.	33.	24.	29.
CO CONCENTRATION PPM	141.	147.	174.	142.
CO2 CONCENTRATION PCT	.34	.52	1.32	.33
NOX CONCENTRATION PPM	16.7	25.4	80.8	17.7
HC MASS GRAMS	4.17	5.63	4.21	5.12
CO MASS GRAMS	48.31	50.76	61.23	50.35
CO2 MASS GRAMS	1819.3	2842.2	7298.6	1815.4
NOX MASS GRAMS	9.36	14.42	46.76	10.33
FUEL KG (LB)	.605 (1.33)	.932 (2.05)	2.349 (5.18)	.606 (1.34)
KW HR (HP HR)	2.30 (3.08)	3.48 (4.67)	10.07 (13.51)	2.32 (3.11)
BSHC G/KW HR (G/HP HR)	1.82 (1.35)	1.62 (1.21)	.42 (.31)	2.21 (1.65)
BSCO G/KW HR (G/HP HR)	21.04 (15.69)	14.58 (10.87)	6.08 (4.53)	21.71 (16.19)
BSCO2 G/KW HR (G/HP HR)	792.12 (590.69)	816.17 (608.62)	724.47 (540.24)	782.81 (583.74)
BSNOX G/KW HR (G/HP HR)	4.07 (3.04)	4.14 (3.09)	4.64 (3.46)	4.45 (3.32)
BSFC KG/KW HR (LB/HP HR)	.263 (.433)	.268 (.440)	.233 (.383)	.261 (.429)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	18.17 (24.37)
BSHC G/KW HR (G/HP HR)	1.05 (.79)
BSCO G/KW HR (G/HP HR)	11.59 (8.64)
BSCO2 G/KW HR (G/HP HR)	758. (565.)
BSNOX G/KW HR (G/HP HR)	4.45 (3.32)
BSFC KG/KW HR (LB/HP HR)	.247 (.406)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	29.61
	G/KWHR(G/HPHR)	1.63 (1.21)
	G/KG FUEL (G/LB FUEL)	6.59 (2.99)
	FILTER EFF.	99.0

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

TEST NO.10-19 RUN1
DATE 8/ 1/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

RELATIVE HUMIDITY , ENGINE-45. PCT , CVS-47. PCT
ABSOLUTE HUMIDITY 9.1 GM/KG(63.9 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

BAROMETER 741.43 MM HG(29.19 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

BAG RESULTS

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	295.9	299.9	304.9	313.7
TOT. BLOWER RATE SCMM (SCFM)	59.34 (2095.4)	59.34 (2095.2)	59.36 (2096.1)	59.35 (2095.8)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.04 (1.30)	.04 (1.30)	.04 (1.30)	.04 (1.30)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	292.8 (10340.)	296.8 (10479.)	301.9 (10658.)	310.5 (10964.)
HC SAMPLE METER/RANGE/PPM	34.0/11/ 34.	41.1/11/ 41.	27.9/11/ 28.	32.1/11/ 32.
HC BCKGRD METER/RANGE/PPM	5.0/ 1/ 5.	5.6/ 1/ 6.	5.2/ 1/ 5.	5.3/ 1/ 5.
CO SAMPLE METER/RANGE/PPM	86.1/12/ 208.	93.9/12/ 235.	77.9/11/ 347.	59.2/11/ 232.
CO BCKGRD METER/RANGE/PPM	.3/12/ 1.	.5/12/ 1.	.4/11/ 1.	.5/11/ 1.
CO2 SAMPLE METER/RANGE/PCT	84.9/12/ .37	66.3/11/ .56	71.8/ 3/ 1.30	84.1/12/ .37
CO2 BCKGRD METER/RANGE/PCT	12.5/12/ .04	7.3/11/ .04	3.2/ 3/ .05	12.4/12/ .04
NOX SAMPLE METER/RANGE/PPM	40.7/ 1/ 12.	59.1/ 1/ 18.	51.6/ 2/ 52.	44.5/ 1/ 13.
NOX BCKGRD METER/RANGE/PPM	1.1/ 1/ 0.	1.3/ 1/ 0.	.2/ 2/ 0.	.9/ 1/ 0.
DILUTION FACTOR	33.81	22.82	10.02	34.02
HC CONCENTRATION PPM	29.	36.	23.	27.
CO CONCENTRATION PPM	203.	228.	332.	225.
CO2 CONCENTRATION PCT	.33	.52	1.26	.33
NOX CONCENTRATION PPM	11.8	17.2	51.4	13.0
HC MASS GRAMS	4.92	6.11	4.04	4.82
CO MASS GRAMS	69.29	78.61	116.78	81.48
CO2 MASS GRAMS	1776.6	2825.2	6945.5	1859.6
NOX MASS GRAMS	6.60	9.77	29.68	7.71
FUEL KG (LB)	.603 (1.33)	.941 (2.07)	2.264 (4.99)	.635 (1.40)
KW HR (HP HR)	2.31 (3.10)	3.45 (4.63)	9.89 (13.26)	2.35 (3.15)
BSHC G/KW HR (G/HP HR)	2.13 (1.59)	1.77 (1.32)	.41 (.30)	2.05 (1.53)
BSCO G/KW HR (G/HP HR)	29.97 (22.35)	22.77 (16.98)	11.81 (8.81)	34.69 (25.87)
BSCO2 G/KW HR (G/HP HR)	768.54 (573.10)	818.30 (610.20)	702.42 (523.79)	791.66 (590.34)
BSNOX G/KW HR (G/HP HR)	2.86 (2.13)	2.83 (2.11)	3.00 (2.24)	3.28 (2.45)
BSFC KG/KW HR (LB/HP HR)	.261 (.429)	.273 (.448)	.229 (.376)	.270 (.444)

TOTAL TEST RESULTS 4 BAGS

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

TOTAL KW HR (HP HR)	18.00 (24.14)	
BSHC G/KW HR (G/HP HR)	1.11 (.82)	
BSCO G/KW HR (G/HP HR)	19.23 (14.34)	
BSCO2 G/KW HR (G/HP HR)	745. (555.)	
BSNOX G/KW HR (G/HP HR)	2.99 (2.23)	
BSFC KG/KW HR (LB/HP HR)	.247 (.406)	
90MM PARTICULATE RATES	GRAMS/TEST	52.30
	G/KWHR(G/HPHR)	2.91 (2.17)
	G/KG FUEL (G/LB FUEL)	11.77 (5.34)
	FILTER EFF.	98.9

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-20 RUN1
DATE 8/ 3/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 744.22 MM HG(29.30 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-55. PCT , CVS-65. PCT
ABSOLUTE HUMIDITY 11.2 GM/KG(78.1 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	295.9	300.0	304.9	307.8
TOT. BLOWER RATE SCMM (SCFM)	59.79 (2111.2)	59.77 (2110.6)	59.80 (2111.6)	59.80 (2111.4)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.66)	.05 (1.66)	.05 (1.66)	.05 (1.66)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	295.1 (10420.)	299.1 (10562.)	304.1 (10739.)	307.0 (10840.)
HC SAMPLE METER/RANGE/PPM	30.3/11/ 30.	37.0/11/ 37.	26.4/11/ 26.	34.3/11/ 34.
HC BCKGRD METER/RANGE/PPM	7.7/ 1/ 8.	7.3/ 1/ 7.	7.0/ 1/ 7.	7.0/ 1/ 7.
CO SAMPLE METER/RANGE/PPM	91.7/13/ 92.	99.8/13/ 102.	52.1/12/ 111.	88.5/13/ 89.
CO BCKGRD METER/RANGE/PPM	2.1/13/ 2.	1.8/13/ 2.	.7/12/ 1.	2.0/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	83.0/12/ .36	62.2/11/ .51	65.9/ 3/ 1.18	75.2/12/ .32
CO2 BCKGRD METER/RANGE/PCT	14.5/12/ .05	8.2/11/ .05	3.5/ 3/ .05	14.2/12/ .05
NOX SAMPLE METER/RANGE/PPM	47.6/ 1/ 14.	70.9/ 1/ 21.	61.2/ 2/ 61.	46.5/ 1/ 14.
NOX BCKGRD METER/RANGE/PPM	.7/ 1/ 0.	.8/ 1/ 0.	.4/ 2/ 0.	.7/ 1/ 0.
DILUTION FACTOR	35.85	25.47	11.22	40.51
HC CONCENTRATION PPM	23.	30.	20.	28.
CO CONCENTRATION PPM	88.	97.	105.	85.
CO2 CONCENTRATION PCT	.31	.47	1.13	.27
NOX CONCENTRATION PPM	14.0	20.9	60.8	13.6
HC MASS GRAMS	3.89	5.17	3.52	4.87
CO MASS GRAMS	30.26	33.86	37.22	30.26
CO2 MASS GRAMS	1693.3	2556.7	6304.4	1524.9
NOX MASS GRAMS	7.88	11.93	35.38	8.00
FUEL KG (LB)	.556 (1.23)	.833 (1.84)	2.021 (4.46)	.503 (1.11)
KW HR (HP HR)	2.16 (2.89)	3.27 (4.39)	9.47 (12.70)	2.30 (3.09)
BSHC G/KW HR (G/HP HR)	1.80 (1.34)	1.58 (1.18)	.37 (.28)	2.11 (1.58)
BSCO G/KW HR (G/HP HR)	14.04 (10.47)	10.34 (7.71)	3.93 (2.93)	13.13 (9.79)
BSCO2 G/KW HR (G/HP HR)	785.74 (585.93)	780.99 (582.38)	665.70 (496.41)	661.81 (493.51)
BSNOX G/KW HR (G/HP HR)	3.66 (2.73)	3.65 (2.72)	3.74 (2.79)	3.47 (2.59)
BSFC KG/KW HR (LB/HP HR)	.258 (.424)	.254 (.418)	.213 (.351)	.218 (.359)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.20 (23.07)
BSHC G/KW HR (G/HP HR)	1.01 (.76)
BSCO G/KW HR (G/HP HR)	7.65 (5.70)
BSCO2 G/KW HR (G/HP HR)	702. (524.)
BSNOX G/KW HR (G/HP HR)	3.67 (2.74)
BSFC KG/KW HR (LB/HP HR)	.227 (.374)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	23.24
	G/KWHR(G/HPHR)	1.35 (1.01)
	G/KG FUEL (G/LB FUEL)	5.94 (2.69)
	FILTER EFF.	98.5

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

TEST NO.10-20 PUN2
DATE 8/ 3/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

RELATIVE HUMIDITY , ENGINE-55. PCT , CVS-62. PCT
ABSOLUTE HUMIDITY 11.2 GM/KG(78.1 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

BAROMETER 743.97 MM HG(29.29 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

BAG RESULTS

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	295.8	299.8	304.7	309.7
TOT. BLOWER RATE SCMM (SCFM)	59.77 (2110.5)	59.76 (2110.3)	59.80 (2111.6)	59.79 (2111.1)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.68)	.05 (1.68)	.05 (1.68)	.05 (1.68)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	294.9 (10413.)	298.9 (10553.)	303.9 (10732.)	308.8 (10905.)
HC SAMPLE METER/RANGE/PPM	33.7/11/ 34.	37.3/11/ 37.	26.0/11/ 26.	34.4/11/ 34.
HC BCKGRD METER/RANGE/PPM	6.9/ 1/ 7.	6.9/ 1/ 7.	6.8/ 1/ 7.	6.7/ 1/ 7.
CO SAMPLE METER/RANGE/PPM	97.6/13/ 99.	97.0/13/ 99.	57.3/12/ 124.	49.2/12/ 104.
CO BCKGRD METER/RANGE/PPM	2.5/13/ 2.	2.9/13/ 3.	1.6/12/ 3.	1.4/12/ 3.
CO2 SAMPLE METER/RANGE/PCT	81.7/12/ .35	61.7/11/ .51	70.1/ 3/ 1.27	81.0/12/ .35
CO2 BCKGRD METER/RANGE/PCT	14.1/12/ .05	8.0/11/ .05	3.0/ 3/ .05	13.2/12/ .04
NOX SAMPLE METER/RANGE/PPM	48.9/ 1/ 15.	71.0/ 1/ 21.	67.6/ 2/ 68.	51.7/ 1/ 15.
NOX BCKGRD METER/RANGE/PPM	1.1/ 1/ 0.	1.3/ 1/ 0.	.3/ 2/ 0.	.9/ 1/ 0.
DILUTION FACTOR	36.47	25.76	10.46	36.81
HC CONCENTRATION PPM	27.	31.	20.	28.
CO CONCENTRATION PPM	95.	93.	116.	99.
CO2 CONCENTRATION PCT	.31	.46	1.22	.31
NOX CONCENTRATION PPM	14.2	20.7	67.3	15.1
HC MASS GRAMS	4.59	5.28	3.49	4.97
CO MASS GRAMS	32.45	32.44	41.14	35.47
CO2 MASS GRAMS	1660.0	2529.9	6814.9	1734.0
NOX MASS GRAMS	8.02	11.86	39.13	8.93
FUEL KG (LB)	.547 (1.21)	.824 (1.82)	2.185 (4.82)	.572 (1.26)
KW HR (HP HR)	2.22 (2.98)	3.30 (4.43)	9.63 (12.92)	2.16 (2.90)
RSHC G/KW HR (G/HP HR)	2.06 (1.54)	1.60 (1.19)	.36 (.27)	2.30 (1.71)
RSCO G/KW HR (G/HP HR)	14.60 (10.89)	9.82 (7.32)	4.27 (3.18)	16.40 (12.23)
RSCO2 G/KW HR (G/HP HR)	746.99 (557.03)	765.84 (571.08)	707.34 (527.47)	801.83 (597.93)
RSNOX G/KW HR (G/HP HR)	3.61 (2.69)	3.59 (2.68)	4.06 (3.03)	4.13 (3.08)
RSFC KG/KW HR (LB/HP HR)	.246 (.405)	.249 (.410)	.227 (.373)	.265 (.435)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	23.05
	G/KWHR(G/HPHR)	1.33 (.99)
	G/KG FUEL (G/LB FUEL)	5.58 (2.53)
	FILTER EFF.	98.2

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.32 (23.23)
RSHC G/KW HR (G/HP HR)	1.06 (.79)
RSCO G/KW HR (G/HP HR)	8.17 (6.09)
RSCO2 G/KW HR (G/HP HR)	735. (548.)
RSNOX G/KW HR (G/HP HR)	3.92 (2.93)
RSFC KG/KW HR (LB/HP HR)	.238 (.392)

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-21 RUN1
DATE 8/ 6/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 744.47 MM HG(29.31 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-45. PCT , CVS-62. PCT
ABSOLUTE HUMIDITY 9.1 GM/KG(63.7 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS	1	2	3	4
BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	296.0	299.8	304.7	313.7
TOT. BLOWER RATE SCMM (SCFM)	59.73 (2109.1)	59.73 (2109.0)	59.72 (2108.8)	59.71 (2108.4)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.79)	.05 (1.79)	.05 (1.79)	.05 (1.79)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	294.9 (10414.)	298.7 (10547.)	303.6 (10718.)	312.5 (11033.)
HC SAMPLE METER/RANGE/PPM	33.4/11/ 33.	37.1/11/ 37.	26.4/11/ 26.	34.4/11/ 34.
HC BCKGRD METER/RANGE/PPM	8.8/ 1/ 9.	8.2/ 1/ 8.	8.0/ 1/ 8.	8.0/ 1/ 8.
CO SAMPLE METER/RANGE/PPM	49.3/12/ 104.	49.4/12/ 104.	54.5/12/ 117.	42.8/12/ 89.
CO BCKGRD METER/RANGE/PPM	1.4/12/ 3.	1.8/12/ 3.	2.1/12/ 4.	2.2/12/ 4.
CO2 SAMPLE METER/RANGE/PCT	86.8/12/ .38	65.1/11/ .55	69.0/ 3/ 1.24	82.2/12/ .36
CO2 BCKGRD METER/RANGE/PCT	12.5/12/ .04	7.5/11/ .04	2.3/ 3/ .04	13.1/12/ .04
NOX SAMPLE METER/RANGE/PPM	62.5/ 1/ 19.	84.6/ 1/ 25.	73.0/ 2/ 73.	60.2/ 1/ 18.
NOX BCKGRD METER/RANGE/PPM	.4/ 1/ 0.	1.0/ 1/ 0.	.1/ 2/ 0.	.5/ 1/ 0.
DILUTION FACTOR	33.74	23.93	10.65	36.29
HC CONCENTRATION PPM	25.	29.	19.	27.
CO CONCENTRATION PPM	99.	98.	109.	82.
CO2 CONCENTRATION PCT	.34	.50	1.21	.31
NOX CONCENTRATION PPM	18.5	24.9	72.9	17.8
HC MASS GRAMS	4.23	5.03	3.35	4.79
CO MASS GRAMS	33.94	34.11	38.37	29.92
CO2 MASS GRAMS	1849.0	2759.2	6735.8	1795.0
NOX MASS GRAMS	10.42	14.21	42.32	10.61
FUEL KG (LB)	.607 (1.34)	.897 (1.98)	2.158 (4.76)	.589 (1.30)
KW HR (HP HR)	2.21 (2.96)	3.27 (4.38)	9.60 (12.88)	2.24 (3.00)
BSHC G/KW HR (G/HP HR)	1.92 (1.43)	1.54 (1.15)	.35 (.26)	2.14 (1.60)
BSCO G/KW HR (G/HP HR)	15.38 (11.47)	10.44 (7.79)	4.00 (2.98)	13.38 (9.97)
BSCO2 G/KW HR (G/HP HR)	837.68 (624.66)	844.77 (629.95)	701.31 (522.97)	802.37 (598.33)
BSNOX G/KW HR (G/HP HR)	4.72 (3.52)	4.35 (3.24)	4.41 (3.29)	4.74 (3.54)
BSFC KG/KW HR (LB/HP HR)	.275 (.452)	.275 (.451)	.225 (.369)	.263 (.433)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.32 (23.22)
BSHC G/KW HR (G/HP HR)	1.01 (.75)
BSCO G/KW HR (G/HP HR)	7.87 (5.87)
BSCO2 G/KW HR (G/HP HR)	759. (566.)
BSNOX G/KW HR (G/HP HR)	4.48 (3.34)
BSFC KG/KW HR (LB/HP HR)	.246 (.404)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	20.87
	G/KWHR(G/HPHR)	1.21 (.90)
	G/KG FUEL (G/LB FUEL)	4.91 (2.23)
	FILTER EFF.	98.1

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-21 RUN2
DATE 8/ 6/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 744.47 MM HG(29.31 IN HG)
DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)

RELATIVE HUMIDITY , ENGINE-45. PCT , CVS-58. PCT
ABSOLUTE HUMIDITY 9.1 GM/KG(63.7 GRAINS/LB)

NOX HUMIDITY C.F. 1.0000

BAG RESULTS	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	295.9	299.9	304.9	310.8
TOT. BLOWER RATE SCMM (SCFM)	59.72 (2108.8)	59.73 (2108.9)	59.73 (2109.1)	59.72 (2108.7)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.76)	.05 (1.76)	.05 (1.76)	.05 (1.76)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	294.8 (10408.)	298.8 (10550.)	303.8 (10727.)	309.6 (10932.)
HC SAMPLE METER/RANGE/PPM	31.8/11/ 32.	34.7/11/ 35.	24.8/11/ 25.	33.0/11/ 33.
HC BCKGRD METER/RANGE/PPM	7.4/ 1/ 7.	7.2/ 1/ 7.	6.9/ 1/ 7.	6.8/ 1/ 7.
CO SAMPLE METER/RANGE/PPM	44.5/12/ 93.	45.9/12/ 96.	56.2/12/ 122.	43.5/12/ 90.
CO BCKGRD METER/RANGE/PPM	1.3/12/ 2.	1.3/12/ 2.	1.5/12/ 3.	1.6/12/ 3.
CO2 SAMPLE METER/RANGE/PCT	83.9/12/ .37	64.4/11/ .54	71.4/ 3/ 1.29	82.4/12/ .36
CO2 BCKGRD METER/RANGE/PCT	12.9/12/ .04	7.5/11/ .04	2.8/ 3/ .04	13.1/12/ .04
NOX SAMPLE METER/RANGE/PPM	58.4/ 1/ 17.	84.0/ 1/ 25.	75.4/ 2/ 75.	61.3/ 1/ 18.
NOX BCKGRD METER/RANGE/PPM	.4/ 1/ 0.	.6/ 1/ 0.	.1/ 2/ 0.	.6/ 1/ 0.
DILUTION FACTOR	35.35	24.34	10.25	36.18
HC CONCENTRATION PPM	25.	28.	19.	26.
CO CONCENTRATION PPM	88.	91.	114.	85.
CO2 CONCENTRATION PCT	.32	.50	1.25	.31
NOX CONCENTRATION PPM	17.3	24.8	75.3	18.1
HC MASS GRAMS	4.19	4.79	3.25	4.72
CO MASS GRAMS	30.16	31.60	40.25	30.65
CO2 MASS GRAMS	1749.5	2715.1	6975.0	1785.0
NOX MASS GRAMS	9.73	14.18	43.75	10.69
FUEL KG (LB)	.574 (1.27)	.881 (1.94)	2.235 (4.93)	.586 (1.29)
KW HR (HP HR)	2.20 (2.95)	3.39 (4.55)	9.78 (13.11)	2.26 (3.03)
BSHC G/KW HR (G/HP HR)	1.90 (1.42)	1.41 (1.05)	.33 (.25)	2.09 (1.56)
BSCO G/KW HR (G/HP HR)	13.71 (10.22)	9.31 (6.95)	4.12 (3.07)	13.57 (10.12)
BSCO2 G/KW HR (G/HP HR)	795.28 (593.04)	800.22 (596.73)	713.47 (532.03)	789.99 (589.10)
BSNOX G/KW HR (G/HP HR)	4.42 (3.30)	4.18 (3.12)	4.48 (3.34)	4.73 (3.53)
BSFC KG/KW HR (LB/HP HR)	.261 (.429)	.260 (.427)	.229 (.376)	.259 (.426)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	17.63 (23.64)
BSHC G/KW HR (G/HP HR)	.96 (.72)
BSCO G/KW HR (G/HP HR)	7.53 (5.61)
BSCO2 G/KW HR (G/HP HR)	750. (559.)
BSNOX G/KW HR (G/HP HR)	4.44 (3.31)
BSFC KG/KW HR (LB/HP HR)	.243 (.399)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	20.41
	G/KWHR(G/HPHR)	1.16 (.86)
	G/KG FUEL (G/LB FUEL)	4.77 (2.16)
	FILTER EFF.	98.4

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

TEST NO.10-22 RUN1
DATE 8/ 6/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

BAROMETER 743.20 MM HG(29.26 IN HG)
DRY BULB TEMP. 26.7 DEG C(80.0 DEG F)

RELATIVE HUMIDITY , ENGINE-38. PCT , CVS-59. PCT
ABSOLUTE HUMIDITY 8.5 GM/KG(59.4 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	NYNF	LANF	LAF	NYNF
TIME SECONDS	295.9	299.9	305.0	306.0
TOT. BLOWER RATE SCMM (SCFM)	59.21 (2090.5)	59.21 (2090.7)	59.21 (2090.8)	59.20 (2090.5)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.87)	.05 (1.87)	.05 (1.87)	.05 (1.87)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	292.2 (10319.)	296.2 (10459.)	301.3 (10638.)	302.2 (10671.)
HC SAMPLE METER/RANGE/PPM	30.7/11/ 31.	32.7/11/ 33.	26.3/11/ 26.	32.6/11/ 33.
HC BCKGRD METER/RANGE/PPM	5.3/ 1/ 5.	5.2/ 1/ 5.	5.0/ 1/ 5.	5.0/ 1/ 5.
CO SAMPLE METER/RANGE/PPM	65.2/13/ 63.	55.7/13/ 53.	54.3/13/ 52.	63.4/13/ 61.
CO BCKGRD METER/RANGE/PPM	.9/13/ 1.	1.2/13/ 1.	.8/13/ 1.	.8/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	86.4/12/ .38	68.3/11/ .58	77.8/ 3/ 1.42	86.8/12/ .38
CO2 BCKGRD METER/RANGE/PCT	12.6/12/ .04	7.2/11/ .04	2.3/ 3/ .04	12.4/12/ .04
NOX SAMPLE METER/RANGE/PPM	32.8/ 2/ 33.	53.7/ 2/ 54.	53.8/ 3/ 161.	34.7/ 2/ 35.
NOX BCKGRD METER/RANGE/PPM	.1/ 2/ 0.	.1/ 2/ 0.	.1/ 3/ 0.	.1/ 2/ 0.
DILUTION FACTOR	34.31	22.61	9.36	34.11
HC CONCENTRATION PPM	26.	28.	22.	28.
CO CONCENTRATION PPM	61.	50.	49.	59.
CO2 CONCENTRATION PCT	.34	.54	1.39	.34
NOX CONCENTRATION PPM	32.7	53.6	161.1	34.6
HC MASS GRAMS	4.30	4.73	3.78	4.84
CO MASS GRAMS	20.60	17.37	17.02	20.67
CO2 MASS GRAMS	1817.7	2953.5	7682.4	1896.5
NOX MASS GRAMS	18.28	30.37	92.84	20.00
FUEL KG (LB)	.591 (1.30)	.950 (2.09)	2.448 (5.40)	.616 (1.36)
KW HR (HP HR)	2.50 (3.35)	3.85 (5.16)	10.90 (14.62)	2.34 (3.14)
BSHC G/KW HR (G/HP HR)	1.72 (1.28)	1.23 (.92)	.35 (.26)	2.07 (1.54)
BSCO G/KW HR (G/HP HR)	8.25 (6.15)	4.52 (3.37)	1.56 (1.16)	8.83 (6.58)
BSCO2 G/KW HR (G/HP HR)	727.62 (542.59)	767.58 (572.39)	704.67 (525.47)	809.97 (603.99)
BSNOX G/KW HR (G/HP HR)	7.32 (5.46)	7.89 (5.88)	8.52 (6.35)	8.54 (6.37)
BSFC KG/KW HR (LB/HP HR)	.237 (.389)	.247 (.406)	.225 (.369)	.263 (.433)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	19.59 (26.27)
BSHC G/KW HR (G/HP HR)	.90 (.67)
BSCO G/KW HR (G/HP HR)	3.86 (2.88)
BSCO2 G/KW HR (G/HP HR)	733. (546.)
BSNOX G/KW HR (G/HP HR)	8.24 (6.15)
BSFC KG/KW HR (LB/HP HR)	.235 (.386)

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES	GRAMS/TEST	11.38
	G/KWHR(G/HPHR)	.58 (.43)
	G/KG FUEL (G/LB FUEL)	2.47 (1.12)
	FILTER EFF.	97.3

ENGINE NO.C10
ENGINE MODEL 84 CUMMINS NTC-350
ENGINE 14.0 L(855. CID) I-6
CVS NO. 11

BAROMETER 742.70 MM HG(29.24 IN HG)
DRY BULB TEMP. 26.7 DEG C(80.0 DEG F)

BAG RESULTS

	1	2	3	4
BAG NUMBER	NYNF	LANF	LAF	NYNF
DESCRIPTION				
TIME SECONDS	296.0	300.1	305.1	312.0
TOT. BLOWER RATE SCMM (SCFM)	59.18 (2089.7)	59.15 (2088.7)	59.17 (2089.2)	59.16 (2088.8)
TOT. 20X20 RATE SCMM (SCFM)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOT. 90MM RATE SCMM (SCFM)	.05 (1.84)	.05 (1.84)	.05 (1.84)	.05 (1.84)
TOT. AUX. SAMPLE RATE SCMM (SCFM)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
TOTAL FLOW STD. CU. METRES(SCF)	292.2 (10318.)	296.1 (10456.)	301.1 (10633.)	307.9 (10871.)
HC SAMPLE METER/RANGE/PPM	32.9/11/ 33.	35.1/11/ 35.	26.8/11/ 27.	32.8/11/ 33.
HC BCKGRD METER/RANGE/PPM	5.0/ 1/ 5.	4.8/ 1/ 5.	4.6/ 1/ 5.	4.3/ 1/ 4.
CO SAMPLE METER/RANGE/PPM	70.7/13/ 69.	57.7/13/ 55.	52.6/13/ 50.	64.7/13/ 62.
CO BCKGRD METER/RANGE/PPM	1.1/13/ 1.	1.1/13/ 1.	.6/13/ 1.	.9/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	87.5/12/ .39	71.1/11/ .62	77.6/ 3/ 1.42	91.1/12/ .41
CO2 BCKGRD METER/RANGE/PCT	11.8/12/ .04	6.9/11/ .04	2.7/ 3/ .04	12.0/12/ .04
NOX SAMPLE METER/RANGE/PPM	33.1/ 2/ 33.	58.1/ 2/ 58.	54.2/ 3/ 163.	38.1/ 2/ 38.
NOX BCKGRD METER/RANGE/PPM	.1/ 2/ 0.	.1/ 2/ 0.	.1/ 3/ 0.	.3/ 2/ 0.
DILUTION FACTOR	33.69	21.35	9.39	32.00
HC CONCENTRATION PPM	28.	31.	23.	29.
CO CONCENTRATION PPM	66.	52.	47.	60.
CO2 CONCENTRATION PCT	.35	.58	1.38	.37
NOX CONCENTRATION PPM	33.0	58.0	162.3	37.8
HC MASS GRAMS	4.72	5.22	3.93	5.09
CO MASS GRAMS	22.52	18.10	16.51	21.52
CO2 MASS GRAMS	1867.0	3150.2	7625.8	2085.5
NOX MASS GRAMS	18.44	32.85	93.49	22.26
FUEL KG (LB)	.608 (1.34)	1.013 (2.23)	2.430 (5.36)	.677 (1.49)
KW HR (HP HR)	2.49 (3.34)	3.92 (5.26)	10.86 (14.57)	2.42 (3.25)
BSHC G/KW HR (G/HP HR)	1.90 (1.41)	1.33 (.99)	.36 (.27)	2.10 (1.57)
BSCO G/KW HR (G/HP HR)	9.04 (6.74)	4.61 (3.44)	1.52 (1.13)	8.88 (6.62)
BSCO2 G/KW HR (G/HP HR)	749.61 (558.99)	803.13 (598.89)	701.88 (523.39)	860.52 (641.69)
BSNOX G/KW HR (G/HP HR)	7.40 (5.52)	8.37 (6.24)	8.60 (6.42)	9.19 (6.85)
BSFC KG/KW HR (LB/HP HR)	.244 (.401)	.258 (.425)	.224 (.368)	.279 (.459)

TOTAL TEST RESULTS 4 BAGS

TOTAL KW HR (HP HR)	19.70 (26.42)
BSHC G/KW HR (G/HP HR)	.96 (.72)
BSCO G/KW HR (G/HP HR)	3.99 (2.98)
BSCO2 G/KW HR (G/HP HR)	748. (557.)
BSNOX G/KW HR (G/HP HR)	8.48 (6.32)
BSFC KG/KW HR (LB/HP HR)	.240 (.395)

ENGINE EMISSION RESULTS
H-TRANS.

PROJECT NO. 03-7338-015

TEST NO.10-22 RUN2
DATE 8/ 6/84
TIME
DYNO NO. 4

DIESEL EM-597-F
BAG CART NO. 1

RELATIVE HUMIDITY , ENGINE-38. PCT , CVS-56. PCT
ABSOLUTE HUMIDITY 8.5 GM/KG(59.4 GRAINS/LB) NOX HUMIDITY C.F. 1.0000

PARTICULATE RESULTS, TOTAL FOR 4 BAGS

90MM PARTICULATE RATES GRAMS/TEST	10.19
G/KWHR(G/HPHR)	.52 (.39)
G/KG FUEL (G/LB FUEL)	2.16 (.98)
FILTER EFF.	95.8

BASELINE 13-MODE TEST, CUMMINS NTC-350

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: CUMMINS BAROMETER: 29.44
TEST-1 FUEL:EM-597-F PROJECT: 03-7338-015 DATE: 5/30/84

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS LB-FT	POWER OBS BHP	FUEL FLOW LB/MIN	AIR FLOW LB/MIN	INTAKE HUMID GR/LB	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 655.	0.	.0	.058	10.23	42.	.925	672.	299.	1.05	75.	94.	84.	32.	1
2	2	INTER / 1250.	24.	5.7	.142	21.38	42.	.937	352.	129.	1.40	115.	95.	70.	95.	2
3	25	INTER / 1250.	296.	70.4	.482	22.34	42.	.940	114.	117.	4.73	515.	33.	65.	441.	3
4	50	INTER / 1250.	592.	140.9	.833	22.81	42.	.941	80.	299.	7.49	1100.	26.	182.	1031.	4
5	75	INTER / 1250.	888.	211.3	1.200	27.57	46.	.950	62.	1061.	9.37	1675.	23.	740.	1812.	5
6	100	INTER / 1250.	1184.	281.8	1.657	33.64	46.	.952	48.	2258.	10.36	2125.	22.	1947.	2846.	6
7		IDLE / 646.	0.	.0	.067	9.97	46.	.931	432.	239.	1.22	100.	62.	68.	43.	7
8	100	RATED / 2100.	844.	337.5	2.037	62.86	46.	.951	80.	117.	6.69	1212.	70.	196.	3145.	8
9	75	RATED / 2100.	633.	253.1	1.568	55.40	48.	.953	68.	94.	5.94	875.	51.	136.	1974.	9
10	50	RATED / 2100.	422.	168.7	1.062	46.01	48.	.952	68.	106.	5.02	550.	41.	123.	993.	10
11	25	RATED / 2100.	211.	84.4	.647	39.40	48.	.952	82.	82.	3.78	300.	39.	77.	438.	11
12	2	RATED / 2100.	17.	6.8	.252	35.51	57.	.981	416.	177.	1.82	130.	155.	131.	154.	12
13		IDLE / 650.	0.	.0	.075	10.16	57.	.977	544.	232.	1.09	80.	96.	82.	45.	13

MODE	CALCULATED GRAMS/LB-FUEL HC	CO	NOX	CALCULATED GRAMS/BHP-HR HC	CO	NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	RSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	26.86	23.93	9.06	**********		******	.0057	.0690	.083	.989	.0055	-4.9	.978	*****	.067	1
2	11.18	8.18	11.15	16.64	12.17	16.59	.0067	.0690	.097	.985	.0069	3.1	.979	1.519	.080	2
3	1.14	2.26	15.26	.47	.93	6.26	.0217	.0690	.314	.957	.0222	2.4	.980	.419	.080	3
4	.52	3.65	20.61	.18	1.29	7.32	.0368	.0690	.533	.935	.0348	-5.4	.983	.361	.080	4
5	.32	10.28	25.16	.11	3.50	8.57	.0438	.0690	.635	.920	.0434	-.8	.988	.345	.080	5
6	.23	19.59	28.63	.08	6.91	10.10	.0496	.0690	.718	.912	.0483	-2.5	.994	.355	.080	6
7	15.42	17.05	10.83	**********		******	.0067	.0690	.098	.987	.0061	-9.2	.981	*****	.067	7
8	.57	1.60	25.74	.21	.58	9.32	.0326	.0690	.473	.941	.0311	-4.7	1.023	.354	.080	8
9	.55	1.45	20.98	.20	.54	7.80	.0285	.0690	.413	.947	.0277	-2.8	1.015	.366	.080	9
10	.64	1.93	15.59	.24	.73	5.88	.0232	.0690	.337	.955	.0235	1.2	1.003	.376	.080	10
11	1.02	1.98	11.28	.47	.91	5.19	.0165	.0690	.239	.965	.0178	7.8	.997	.461	.080	11
12	10.24	8.65	10.17	22.74	19.21	22.59	.0071	.0690	.104	.980	.0089	24.6	.993	2.238	.080	12
13	21.37	18.24	10.02	**********		******	.0074	.0690	.108	.988	.0056	-25.4	.978	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- =	.491	GRAM/BHP-HR
BSCO ------- =	2.475	GRAM/BHP-HR
BSNOX ------ =	8.347	GRAM/BHP-HR
BSHC + BSNOX =	8.839	GRAM/BHP-HR
CORR. BSFC - =	.385	LBS/BHP-HR

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: CUMMINS
TEST-2 FUEL: EM-597-F
BAROMETER: 29.29
PROJECT: 03-7338-015 DATE: 5/31/84

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS LB-FT	POWER OBS BHP	FUEL FLOW LB/MIN	AIR FLOW LB/MIN	INTAKE HUMID GR/LB	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 660.	0.	.0	.060	10.21	54.	.964	536.	262.	1.18	85.	70.	69.	35.	1
2	2	INTER / 1250.	24.	5.7	.103	19.83	54.	.973	276.	106.	1.68	125.	46.	35.	66.	2
3	25	INTER / 1250.	296.	70.4	.410	21.19	54.	.970	110.	106.	5.17	510.	25.	46.	351.	3
4	50	INTER / 1250.	592.	140.9	.928	24.03	57.	.971	132.	336.	8.34	1125.	43.	205.	1088.	4
5	75	INTER / 1250.	888.	211.3	1.233	29.70	57.	.970	76.	1171.	10.25	1625.	27.	767.	1685.	5
6	100	INTER / 1250.	1184.	281.8	1.680	33.46	57.	.967	56.	2408.	11.31	2075.	25.	1929.	2624.	6
7		IDLE / 650.	0.	.0	.058	10.14	70.	1.014	656.	348.	1.05	80.	92.	97.	37.	7
8	100	RATED / 2100.	856.	342.3	2.010	62.35	70.	1.004	68.	117.	7.12	1212.	56.	182.	3082.	8
9	75	RATED / 2100.	642.	256.7	1.568	54.92	75.	1.023	58.	94.	6.43	887.	41.	126.	1986.	9
10	50	RATED / 2100.	428.	171.1	1.080	45.62	75.	1.030	62.	82.	5.39	545.	35.	90.	1009.	10
11	25	RATED / 2100.	214.	85.6	.683	40.16	70.	1.021	80.	94.	3.91	295.	39.	90.	471.	11
12	2	RATED / *****	17.	68.3	.262	34.98	70.	1.031	352.	153.	1.97	130.	127.	109.	156.	12
13		IDLE / 660.	0.	.0	.055	10.14	70.	1.029	592.	262.	1.09	80.	76.	68.	35.	13

MODE	CALCULATED GRAMS/LB-FUEL HC	CO	NOX	CALCULATED GRAMS/BHP-HR HC	CO	NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	19.55	19.09	9.75	**********		******	.0059	.0690	.086	.987	.0060	1.1	.984	*****	.067	1
2	7.42	5.67	10.61	8.06	6.15	11.52	.0053	.0690	.076	.981	.0081	55.1	.986	1.101	.080	2
3	1.01	1.88	14.28	.35	.65	4.99	.0195	.0690	.283	.952	.0242	24.2	.987	.354	.080	3
4	.77	3.68	19.52	.30	1.45	7.72	.0390	.0690	.565	.928	.0386	-.9	.988	.400	.080	4
5	.36	10.37	22.77	.13	3.63	7.97	.0419	.0690	.607	.912	.0474	13.1	.993	.353	.080	5
6	.24	19.14	26.03	.09	6.85	9.31	.0506	.0690	.734	.904	.0525	3.8	.996	.359	.080	6
7	26.18	27.77	10.56	**********		******	.0058	.0690	.084	.987	.0055	-5.8	.985	*****	.067	7
8	.46	1.51	25.56	.16	.53	9.01	.0326	.0690	.472	.937	.0330	1.4	1.028	.343	.080	8
9	.43	1.34	21.10	.16	.49	7.74	.0289	.0690	.418	.942	.0299	3.6	1.016	.361	.080	9
10	.55	1.39	15.57	.21	.53	5.90	.0239	.0690	.347	.950	.0252	5.3	1.006	.376	.080	10
11	.96	2.20	11.49	.46	1.05	5.51	.0172	.0690	.249	.963	.0184	7.2	1.001	.479	.080	11
12	8.07	6.95	9.94	1.86	1.60	2.29	.0076	.0690	.110	.978	.0096	26.6	.996	.231	.080	12
13	23.14	20.46	10.49	**********		******	.0055	.0690	.079	.987	.0056	2.1	.981	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- =	.406	GRAM/BHP-HR
BSCO ------- =	2.310	GRAM/BHP-HR
BSNOX ------ =	7.715	GRAM/BHP-HR
BSHC + BSNOX =	8.120	GRAM/BHP-HR
CORR. BSFC - =	.369	LBS/BHP-HR

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: CUMMINS BAROMETER: 29.15
TEST-3 FUEL: EM-597-F PROJECT: 03-7338-015 DATE: 6/1/84

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS LB-FT	POWER OBS BHP	FUEL FLOW LB/MIN	AIR FLOW LB/MIN	INTAKE HUMID GR/LB	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 660.	0.	.0	.082	10.22	68.	1.008	616.	299.	1.09	75.	117.	114.	47.	1
2	2	INTER / 1250.	24.	5.7	.140	19.75	68.	1.022	360.	141.	1.44	105.	94.	73.	91.	2
3	25	INTER / 1250.	297.	70.7	.438	20.69	68.	1.010	110.	129.	4.87	460.	28.	64.	374.	3
4	50	INTER / 1250.	594.	141.4	.823	23.05	68.	.996	100.	323.	8.05	1025.	30.	181.	934.	4
5	75	INTER / 1250.	891.	212.1	1.377	27.68	65.	.980	80.	1226.	10.25	1562.	32.	896.	1826.	5
6	100	INTER / 1250.	1188.	282.7	1.645	32.83	65.	.981	58.	2408.	11.31	1975.	25.	1889.	2480.	6
7		IDLE / 655.	0.	.0	.072	10.16	65.	.985	680.	336.	1.05	70.	116.	115.	39.	7
8	100	RATED / 2100.	848.	339.1	2.025	62.96	64.	.989	76.	141.	7.12	1175.	63.	220.	2963.	8
9	75	RATED / 2100.	636.	254.3	1.540	53.74	64.	.987	60.	141.	6.27	800.	42.	190.	1739.	9
10	50	RATED / 2100.	424.	169.5	1.102	45.56	64.	.994	62.	106.	5.32	515.	37.	121.	950.	10
11	25	RATED / 2100.	212.	84.8	.647	38.43	64.	.999	78.	117.	3.78	270.	37.	110.	413.	11
12	2	RATED / 2100.	17.	6.8	.298	34.22	61.	.994	388.	189.	1.82	125.	171.	165.	178.	12
13		IDLE / 660.	0.	.0	.072	10.21	61.	.986	576.	299.	1.05	70.	100.	104.	39.	13

MODE	CALCULATED GRAMS/LB-FUEL HC	CO	NOX	CALCULATED GRAMS/BHP-HR HC	CO	NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	23.92	23.23	9.59	**********		******	.0081	.0690	.117	.988	.0056	-30.4	.989	*****	.067	1
2	11.13	8.69	10.80	16.37	12.78	15.88	.0072	.0690	.104	.984	.0071	-1.2	.990	1.485	.080	2
3	1.07	2.42	14.22	.40	.90	5.29	.0214	.0690	.310	.955	.0229	6.9	.991	.375	.080	3
4	.60	3.67	18.90	.21	1.28	6.60	.0361	.0690	.523	.929	.0373	3.4	.994	.352	.080	4
5	.38	10.85	22.11	.15	4.23	8.61	.0502	.0690	.728	.912	.0474	-5.6	.997	.391	.080	5
6	.25	19.14	25.12	.09	6.68	8.77	.0506	.0690	.733	.904	.0525	3.9	1.003	.348	.080	6
7	27.09	26.78	8.97	**********		******	.0071	.0690	.103	.988	.0055	-23.1	.993	*****	.067	7
8	.52	1.81	24.39	.18	.65	8.74	.0325	.0690	.470	.937	.0330	1.8	1.035	.346	.080	8
9	.46	2.06	18.82	.17	.75	6.84	.0289	.0690	.419	.944	.0292	1.0	1.025	.354	.080	9
10	.55	1.82	14.38	.22	.71	5.61	.0244	.0690	.354	.951	.0249	2.0	1.013	.385	.080	10
11	.97	2.83	10.64	.44	1.29	4.87	.0170	.0690	.246	.964	.0178	5.0	1.006	.455	.080	11
12	9.55	9.24	9.92	25.15	24.34	26.12	.0088	.0690	.127	.981	.0089	1.2	1.002	2.628	.080	12
13	23.23	24.13	9.09	**********		******	.0071	.0690	.103	.988	.0054	-23.6	.989	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- = .534 GRAM/BHP-HR
BSCO ------- = 2.673 GRAM/BHP-HR
BSNOX ------ = 7.691 GRAM/BHP-HR
BSHC + BSNOX = 8.225 GRAM/BHP-HR
CORR. BSFC - = .387 LBS/BHP-HR

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: CUMMINS 350
TEST-4 FUEL: EM-597-F
BAROMETER: 29.11
PROJECT: 03-7338-015 DATE: 6/7/84

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS LB-FT	POWER OBS BHP	FUEL FLOW LB/MIN	AIR FLOW LB/MIN	INTAKE HUMID GR/LB	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 685.	0.	.0	.060	9.54	92.	.993	600.	311.	1.13	70.	81.	84.	31.	1
2	2	INTER / 1250.	21.	5.0	.113	17.57	92.	.998	412.	189.	1.54	95.	81.	74.	60.	2
3	25	INTER / 1250.	260.	61.9	.360	18.04	92.	.980	128.	165.	4.87	310.	27.	67.	201.	3
4	50	INTER / 1250.	520.	123.8	.867	19.64	98.	1.038	112.	742.	8.44	620.	33.	416.	588.	4
5	75	INTER / 1250.	780.	185.6	1.233	22.47	98.	1.125	48.	4969.	11.19	790.	15.	2889.	843.	5
6	100	INTER / 1250.	1040.	247.5	1.762	26.70	98.	1.257	24.	2801.	13.84	850.	9.	1926.	1198.	6
7		IDLE / 660.	0.	.0	.068	9.19	98.	.983	544.	323.	1.31	90.	74.	87.	39.	7
8	100	RATED / 2100.	828.	331.1	2.123	47.67	98.	1.040	64.	1198.	9.26	820.	43.	1494.	1735.	8
9	75	RATED / 2100.	621.	248.3	1.685	41.64	98.	1.020	54.	536.	8.05	620.	33.	614.	1182.	9
10	50	RATED / 2100.	414.	165.5	1.172	36.05	98.	.992	60.	262.	6.60	430.	31.	255.	678.	10
11	25	RATED / 2100.	207.	82.8	.642	32.32	98.	.978	72.	177.	4.59	260.	29.	136.	318.	11
12	2	RATED / 2100.	17.	6.8	.290	29.98	98.	1.011	400.	250.	2.17	120.	145.	179.	142.	12
13		IDLE / 2100.	0.	.0	.065	9.26	94.	1.023	288.	336.	1.22	75.	40.	94.	35.	13

MODE	CALCULATED GRAMS/13-FUEL HC	CO	NOX	CALCULATED GRAMS/BHP-HR HC	CO	NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	22.59	23.38	8.53	**********		******	.0064	.0690	.092	.986	.0058	-8.9	1.019	*****	.067	1
2	11.90	10.85	8.88	16.19	14.76	12.08	.0065	.0690	.095	.981	.0076	16.2	1.024	1.329	.080	2
3	1.24	3.09	9.30	.43	1.08	3.25	.0202	.0690	.293	.953	.0229	13.2	1.037	.337	.080	3
4	.64	7.99	11.32	.27	3.36	4.75	.0447	.0690	.648	.925	.0392	-12.3	1.070	.393	.080	4
5	.21	39.04	11.39	.08	15.56	4.54	.0557	.0690	.807	.902	.0532	-4.3	1.098	.363	.080	5
6	.09	18.22	11.34	.04	7.78	4.84	.0669	.0690	.970	.884	.0635	-5.1	1.110	.385	.080	6
7	17.94	21.23	9.49	**********		******	.0075	.0690	.109	.984	.0066	-12.0	1.028	*****	.067	7
8	.34	11.72	13.62	.13	4.51	5.24	.0452	.0690	.654	.918	.0430	-4.7	1.118	.344	.080	8
9	.33	6.07	11.69	.13	2.47	4.76	.0410	.0690	.595	.928	.0374	-8.9	1.100	.370	.080	9
10	.44	3.63	9.64	.19	1.54	4.09	.0330	.0690	.478	.940	.0307	-6.7	1.082	.393	.080	10
11	.74	3.52	8.26	.34	1.64	3.84	.0201	.0690	.292	.955	.0216	7.2	1.061	.439	.080	11
12	8.32	10.27	8.13	21.29	26.29	20.82	.0098	.0690	.142	.976	.0106	7.8	1.039	2.463	.080	12
13	10.34	24.06	8.96	**********		******	.0071	.0690	.103	.985	.0061	-14.4	1.013	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- =	.418	GRAM/BHP-HR
BSCO ------- =	5.671	GRAM/BHP-HR
BSNOX ------ =	4.823	GRAM/BHP-HR
BSHC + BSNOX =	5.240	GRAM/BHP-HR
CORR. BSFC - =	.391	LBS/BHP-HR

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: CUMMINS 350 BAROMETER: 29.21
TEST-5 FUEL: EM-597-F PROJECT: 03-7338-015 DATE: 6/11/84

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE ORS LB-FT	POWER ORS BHP	FUEL FLOW LB/MIN	AIR FLOW LB/MIN	INTAKE HUMID GR/LB	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 680.	0.	.0	.037	9.93	95.	.959	680.	336.	.84	45.	73.	72.	15.	1
2	2	INTER / 1250.	23.	5.5	.130	18.44	95.	1.042	368.	177.	1.58	95.	81.	78.	71.	2
3	25	INTER / 1250.	286.	68.1	.427	19.66	95.	1.006	130.	165.	4.80	360.	33.	80.	288.	3
4	50	INTER / 1250.	573.	136.4	.750	21.07	95.	1.011	112.	448.	7.86	780.	31.	234.	672.	4
5	75	INTER / 1250.	859.	204.4	1.178	21.53	96.	1.083	76.	1893.	10.02	1125.	26.	1203.	1264.	5
6	100	INTER / 1250.	1146.	272.8	1.577	30.44	90.	1.066	46.	4728.	11.31	1412.	19.	3486.	1810.	6
7		IDLE / 680.	0.	.0	.040	9.82	90.	.952	680.	385.	.80	50.	83.	94.	19.	7
8	100	RATED / 2100.	862.	344.7	1.968	57.07	94.	1.010	80.	238.	7.49	980.	61.	343.	2331.	8
9	75	RATED / 2100.	646.	258.3	1.563	50.13	94.	1.000	64.	166.	6.69	700.	43.	213.	1466.	9
10	50	RATED / 2100.	431.	172.3	1.140	42.22	94.	.996	64.	141.	5.62	445.	37.	157.	806.	10
11	25	RATED / 2100.	215.	86.0	.617	36.62	94.	.988	76.	141.	3.98	240.	33.	120.	329.	11
12	2	RATED / 2100.	17.	6.8	.280	32.41	103.	1.052	408.	226.	1.92	105.	160.	176.	140.	12
13		IDLE / 680.	0.	.0	.043	9.85	103.	1.046	560.	299.	1.01	60.	61.	65.	22.	13

MODE	CALCULATED GRAMS/LB-FUEL HC	CO	NOX	CALCULATED GRAMS/BHP-HR HC	CO	NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWEP CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	33.16	32.75	6.87	**********		******	.0037	.0690	.054	.987	.0045	19.8	1.026	*****	.067	1
2	10.41	9.94	9.07	14.83	14.17	12.93	.0071	.0690	.104	.981	.0078	8.5	1.010	1.411	.080	2
3	1.28	3.14	11.24	.48	1.18	4.23	.0220	.0690	.319	.954	.0226	2.6	1.026	.367	.080	3
4	.69	5.20	14.93	.23	1.72	4.93	.0361	.0690	.523	.930	.0365	1.2	1.043	.316	.080	4
5	.37	17.02	17.88	.13	5.89	6.18	.0555	.0690	.804	.913	.0467	-15.8	1.062	.326	.080	5
6	.20	36.85	19.13	.07	12.78	6.64	.0525	.0690	.760	.901	.0536	2.3	1.074	.323	.080	6
7	34.40	38.98	7.87	**********		******	.0041	.0690	.060	.988	.0043	4.7	1.025	*****	.067	7
8	.52	2.91	19.73	.18	1.00	6.76	.0350	.0690	.507	.933	.0347	-.6	1.080	.317	.080	8
9	.46	2.27	15.63	.17	.82	5.67	.0316	.0690	.458	.939	.0311	-1.6	1.071	.339	.080	9
10	.54	2.30	11.78	.22	.91	4.67	.0274	.0690	.397	.948	.0263	-4.0	1.058	.375	.080	10
11	.90	3.24	8.88	.39	1.39	3.82	.0171	.0690	.247	.961	.0188	10.0	1.045	.412	.080	11
12	9.54	10.46	8.34	23.58	25.86	20.62	.0088	.0690	.127	.978	.0094	7.2	1.027	2.406	.080	12
13	23.51	25.04	8.58	**********		******	.0045	.0690	.065	.985	.0052	16.9	1.012	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- =	.454	GRAM/BHP-HR
BSCO ------- =	4.040	GRAM/BHP-HR
BSNOX ------ =	5.930	GRAM/BHP-HR
BSHC + BSNOX =	6.384	GRAM/BHP-HR
CORR. BSFC - =	.353	LBS/BHP-HR

13-MODE FEDEPAL DIESEL EMISSION CYCLE 1979

ENGINE: CUMMINS NTC-350 BAROMETER: 29.23
TEST-6 FUEL: EM-597-F PROJECT: 03-7338-015 DATE: 6/14/84

MODE	POWER PCT	ENGINE SPEED COND / RPM	TOROUE OBS LB-FT	POWER OBS BHP	FUEL FLOW LB/MIN	AIR FLOW LB/MIN	INTAKE HUMID GR/LB	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 655.	0.	.0	.053	8.92	81.	.770	616.	385.	1.22	70.	69.	86.	20.	1
2	2	INTER / 1250.	22.	5.2	.117	17.26	81.	.888	364.	189.	1.58	100.	72.	74.	57.	2
3	25	INTER / 1250.	275.	65.5	.420	18.31	81.	.897	120.	165.	5.09	350.	28.	75.	232.	3
4	50	INTER / 1250.	551.	131.1	.917	20.67	88.	1.019	108.	574.	8.24	730.	35.	349.	738.	4
5	75	INTER / 1250.	826.	196.6	1.203	24.45	88.	1.076	72.	2924.	10.48	920.	24.	1799.	994.	5
6	100	INTER / 1250.	1102.	262.3	1.658	28.78	88.	1.278	360.	3158.	12.19	1062.	145.	2301.	1614.	6
7		IDLE / 650.	0.	.0	.050	8.85	88.	.748	584.	385.	1.26	80.	59.	78.	20.	7
8	100	RATED / 2100.	836.	334.3	1.992	52.70	88.	.959	92.	448.	8.34	880.	64.	586.	1800.	8
9	75	RATED / 2100.	627.	250.7	1.540	46.01	81.	.903	88.	262.	7.40	650.	53.	299.	1094.	9
10	50	RATED / 2100.	418.	167.1	1.075	39.94	81.	.866	72.	165.	6.10	430.	36.	160.	588.	10
11	25	RATED / 2100.	209.	83.6	.582	33.39	81.	.855	84.	141.	4.18	240.	33.	108.	256.	11
12	2	RATED / 2100.	17.	6.8	.318	30.10	75.	.869	336.	201.	2.17	120.	134.	159.	134.	12
13		IDLE / 660.	0.	.0	.057	8.75	75.	.856	560.	336.	1.26	70.	65.	78.	23.	13

MODE	CALCULATED GRAMS/LB-FUEL HC	CO	NOX	CALCULATED GRAMS/BHP-HR HC	CO	NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	21.47	26.77	6.11	**********		******	.0060	.0690	.088	.985	.0063	3.7	1.083	*****	.067	1
2	10.28	10.61	8.14	13.75	14.19	10.88	.0068	.0690	.099	.982	.0078	13.5	1.043	1.282	.080	2
3	1.12	2.96	9.19	.43	1.14	3.54	.0232	.0690	.336	.952	.0239	2.9	1.066	.361	.080	3
4	.64	6.35	13.42	.27	2.66	5.63	.0449	.0690	.651	.927	.0383	-14.8	1.084	.387	.080	4
5	.33	24.92	13.76	.12	9.15	5.06	.0498	.0690	.722	.909	.0492	-1.3	1.135	.324	.080	5
6	1.45	23.12	16.22	.55	8.77	6.15	.0583	.0690	.846	.896	.0569	-2.5	1.182	.321	.080	6
7	19.83	26.05	6.60	**********		******	.0057	.0690	.083	.984	.0064	12.7	1.100	*****	.067	7
8	.54	4.90	15.07	.19	1.75	5.39	.0383	.0690	.555	.926	.0386	.9	1.153	.310	.080	8
9	.57	3.24	11.84	.21	1.19	4.36	.0339	.0690	.491	.934	.0344	1.4	1.149	.321	.080	9
10	.56	2.48	9.12	.22	.96	3.52	.0272	.0690	.395	.944	.0285	4.5	1.126	.343	.080	10
11	.94	3.08	7.32	.39	1.29	3.06	.0176	.0690	.255	.960	.0197	11.7	1.090	.383	.080	11
12	7.01	8.30	7.03	19.70	23.32	19.74	.0107	.0690	.155	.977	.0105	-1.6	1.060	2.650	.080	12
13	19.09	22.86	6.65	**********		******	.0065	.0690	.095	.985	.0064	-2.0	1.042	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

RSHC ------- = .523 GRAM/BHP-HR
RSCO ------- = 4.065 GRAM/BHP-HR
RSNOX ------ = 5.028 GRAM/BHP-HR
RSHC + RSNOX = 5.551 GRAM/BHP-HR
CORR. BSFC - = .349 LBS/BHP-HR

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE:350 CUMMINS
TEST-7 FUEL:EM-597-F PROJECT:03-7338-015 BAROMETER-29.15 DATE:06/25/1984

MODE	POWER PCT	ENGINE SPEED COND / RPM	TOROUE OBS LB-FT	POWER OBS BHP	FUEL FLOW LB/MIN	AIR FLOW LB/MIN	INTAKE HUMID GR/LB	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 650.	0.	.0	.058	8.49	80.	1.042	624.	410.	1.26	75.	74.	97.	30.	1
2	2	INTER / 1250.	21.	5.0	.113	16.61	80.	1.042	412.	201.	1.58	100.	79.	76.	65.	2
3	25	INTER / 1250.	269.	64.0	.417	17.73	80.	1.027	128.	165.	5.09	305.	30.	74.	229.	3
4	50	INTER / 1250.	538.	128.0	.752	20.09	82.	1.019	116.	536.	8.34	590.	30.	264.	484.	4
5	75	INTER / 1250.	807.	192.1	1.145	22.90	82.	1.008	52.	4013.	10.83	815.	16.	2254.	753.	5
6	100	INTER / 1250.	1076.	256.1	1.647	27.12	82.	.998	20.	3158.	12.85	935.	8.	2177.	1050.	6
7		IDLE / 655.	0.	.0	.060	8.30	87.	1.068	624.	435.	1.22	80.	78.	108.	35.	7
8	100	RATED / 2100.	840.	335.9	2.060	50.83	87.	1.027	106.	638.	8.74	730.	73.	822.	1576.	8
9	75	RATED / 2100.	630.	251.9	1.540	44.34	87.	1.034	72.	299.	7.58	600.	42.	333.	1128.	9
10	50	RATED / 2100.	420.	167.9	1.067	38.30	82.	1.028	72.	177.	6.18	400.	36.	168.	636.	10
11	25	RATED / 2100.	210.	84.0	.602	32.24	82.	1.037	86.	153.	4.38	230.	33.	115.	293.	11
12	2	RATED / 2100.	17.	6.8	.302	29.44	82.	1.045	468.	286.	2.07	125.	183.	222.	165.	12
13		IDLE / 670.	0.	.0	.067	8.48	82.	1.048	584.	348.	1.31	75.	77.	91.	34.	13

MODE	CALCULATED GRAMS/LB-FUEL HC	CO	NOX	CALCULATED GRAMS/BHP-HR HC	CO	NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	21.06	27.61	8.58	**********		******	.0069	.0690	.101	.985	.0065	-6.8	.991	*****	.067	1
2	11.59	11.24	9.51	15.77	15.30	12.94	.0069	.0690	.100	.982	.0078	12.8	.996	1.366	.080	2
3	1.19	2.96	9.17	.46	1.16	3.58	.0238	.0690	.344	.952	.0239	.5	.997	.391	.080	3
4	.68	5.86	10.72	.24	2.06	3.78	.0379	.0690	.549	.926	.0387	2.2	.999	.352	.080	4
5	.23	32.81	10.96	.08	11.73	3.92	.0506	.0690	.733	.906	.0512	1.3	1.003	.357	.080	5
6	.08	22.03	10.63	.03	8.50	4.10	.0614	.0690	.890	.892	.0595	-3.2	1.006	.383	.080	6
7	21.65	30.12	9.66	**********		******	.0073	.0690	.106	.985	.0063	-13.9	.992	*****	.067	7
8	.59	6.65	12.75	.22	2.45	4.69	.0410	.0690	.595	.923	.0405	-1.3	1.041	.354	.080	8
9	.46	3.61	12.21	.17	1.32	4.48	.0352	.0690	.510	.932	.0352	-.0	1.030	.356	.080	9
10	.56	2.62	9.94	.21	1.00	3.79	.0282	.0690	.408	.944	.0288	2.3	1.020	.374	.080	10
11	.92	3.19	8.12	.40	1.37	3.49	.0189	.0690	.274	.958	.0206	9.2	1.013	.424	.080	11
12	10.11	12.24	9.12	26.93	32.59	24.30	.0104	.0690	.150	.978	.0102	-2.0	1.009	2.639	.080	12
13	19.15	22.77	8.39	**********		******	.0080	.0690	.115	.985	.0067	-16.2	.992	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- =	.484	GRAM/BHP-HR
BSCO ------- =	4.527	GRAM/BHP-HR
BSNOX ------ =	4.332	GRAM/BHP-HR
BSHC + BSNOX =	4.815	GRAM/BHP-HR
CORR. BSFC - =	.387	LBS/BHP-HR

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: CUMMINS 350
TEST C10-15 FUEL: EM-597-F PROJECT: 03-7338-015 DATE: 7/24/84

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS LB-FT	POWER OBS BHP	FUEL FLOW LB/MIN	AIR FLOW LB/MIN	INTAKE HUMID GR/LB	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 660.	0.	.0	.090	7.25	77.	1.025	456.	435.	1.40	75.	76.	145.	42.	1
2	2	INTER / 1250.	15.	3.6	.143	14.43	77.	1.027	352.	250.	1.77	95.	76.	108.	69.	2
3	25	INTER / 1250.	175.	41.7	.322	14.80	77.	1.019	154.	213.	4.52	170.	31.	83.	110.	3
4	50	INTER / 1250.	355.	84.5	.528	15.36	75.	1.006	136.	423.	7.40	220.	28.	165.	141.	4
5	75	INTER / 1250.	530.	126.1	.817	16.69	75.	.998	120.	2828.	10.13	250.	28.	1221.	176.	5
6	100	INTER / 1250.	695.	165.4	1.267	17.71	75.	.985	140.	4141.	11.68	240.	44.	2387.	222.	6
7		IDLE / 650.	0.	.0	.087	7.34	75.	1.020	380.	448.	1.54	90.	56.	132.	44.	7
8	100	RATED / 2100.	743.	297.1	2.117	37.64	83.	1.004	136.	6543.	11.55	335.	71.	6247.	524.	8
9	75	RATED / 2100.	568.	227.1	1.617	33.41	83.	1.012	88.	2205.	10.02	295.	41.	1917.	423.	9
10	50	RATED / 2100.	370.	147.9	1.063	29.65	83.	1.024	78.	561.	7.86	230.	31.	415.	284.	10
11	25	RATED / 2100.	187.	74.8	.627	26.36	83.	1.036	84.	262.	5.32	185.	28.	169.	202.	11
12	2	RATED / 2100.	15.	6.0	.292	24.94	83.	1.049	332.	336.	2.71	120.	98.	194.	119.	12
13		IDLE / 655.	0.	.0	.078	7.49	78.	1.031	584.	473.	1.49	80.	79.	128.	36.	13

MODE	CALCULATED GRAMS/LB-FUEL HC	CO	NOX	GRAMS/BHP-HR HC	CO	NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	14.09	26.82	7.74	**********		******	.0125	.0690	.182	.985	.0071	-43.6	.992	*****	.067	1
2	8.89	12.54	7.99	21.41	30.22	19.24	.0100	.0690	.146	.981	.0087	-13.6	.999	2.412	.080	2
3	1.60	4.29	5.70	.74	1.99	2.64	.0220	.0690	.318	.957	.0213	-2.9	.999	.464	.080	3
4	.89	5.21	4.45	.33	1.96	1.67	.0348	.0690	.504	.934	.0345	-.9	1.000	.375	.080	4
5	.57	24.92	3.59	.22	9.68	1.39	.0495	.0690	.717	.912	.0477	-3.7	1.001	.388	.080	5
6	.58	31.41	2.93	.27	14.43	1.34	.0723	.0690	1.047	.900	.0550	-23.9	1.003	.458	.080	6
7	10.79	25.35	8.48	**********		******	.0119	.0690	.173	.984	.0077	-35.5	.993	*****	.067	7
8	.56	49.19	4.13	.24	21.03	1.76	.0569	.0690	.825	.899	.0556	-2.3	1.035	.413	.080	8
9	.43	19.76	4.36	.18	8.44	1.86	.0490	.0690	.710	.913	.0469	-4.3	1.024	.417	.080	9
10	.48	6.50	4.45	.21	2.80	1.92	.0363	.0690	.526	.930	.0365	.7	1.015	.425	.080	10
11	.75	4.49	5.37	.38	2.26	2.70	.0241	.0690	.349	.950	.0250	3.8	1.009	.498	.080	11
12	5.58	11.11	6.79	16.28	32.42	19.81	.0118	.0690	.171	.972	.0131	10.7	1.006	2.900	.080	12
13	16.86	27.21	7.75	**********		******	.0106	.0690	.153	.984	.0076	-28.3	.991	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

RSHC ------- =	.557	GRAM/BHP-HR
RSCO ------- =	11.281	GRAM/BHP-HR
RSNOX ------ =	2.021	GRAM/BHP-HR
RSHC + RSNOX =	2.577	GRAM/BHP-HR
CORR. BSFC - =	.453	LBS/BHP-HR

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: CUMMINS 350 BAROMETER: 29.26
TEST 20 FUEL: EM-597-F PROJECT: 03-7338-015 DATE:8/3/84

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS LB-FT	POWER OBS BHP	FUEL FLOW LB/MIN	AIR FLOW LB/MIN	INTAKE HUMID GR/LB	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 685.	0.	.0	.050	7.76	87.	1.068	600.	448.	1.05	60.	72.	107.	25.	1
2	2	INTER / 1250.	20.	4.8	.107	13.54	80.	1.039	464.	238.	1.40	90.	93.	95.	61.	2
3	25	INTER / 1250.	260.	61.9	.367	15.25	80.	1.026	164.	213.	5.78	200.	30.	74.	116.	3
4	50	INTER / 1250.	525.	125.0	.793	16.67	81.	1.009	128.	1566.	9.69	250.	31.	694.	183.	4
5	75	INTER / 1250.	785.	186.8	1.185	22.99	81.	1.006	52.	5659.	11.31	590.	16.	3111.	532.	5
6	100	INTER / 1250.	1055.	251.1	1.670	27.70	80.	.996	24.	2587.	12.85	820.	9.	1816.	936.	6
7		IDLE / 685.	0.	.0	.047	7.64	80.	1.041	552.	435.	1.13	70.	58.	91.	25.	7
8	100	RATED / 2100.	798.	319.1	2.058	45.30	81.	1.011	74.	1380.	9.69	570.	46.	1592.	1085.	8
9	75	RATED / 2100.	600.	239.9	1.632	39.27	81.	1.015	70.	742.	8.84	405.	38.	748.	676.	9
10	50	RATED / 2100.	399.	159.5	1.112	33.20	80.	1.018	72.	286.	7.12	300.	33.	245.	427.	10
11	25	RATED / 2100.	205.	82.0	.730	29.46	80.	1.025	82.	177.	5.17	210.	33.	137.	272.	11
12	2	RATED / 2100.	16.	6.4	.312	26.65	80.	1.036	234.	213.	2.54	120.	79.	142.	135.	12
13		IDLE / 655.	0.	.0	.078	7.26	80.	1.037	480.	385.	1.35	80.	72.	116.	41.	13

MODE	CALCULATED GRAMS/LB-FUEL HC	CO	NOX	CALCULATED GRAMS/BHP-HR HC	CO	NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	23.86	35.61	8.31	**********		******	.0065	.0690	.095	.987	.0055	-15.8	.988	*****	.067	1
2	14.54	14.86	9.53	19.55	19.98	12.82	.0080	.0690	.115	.984	.0070	-12.4	.990	1.359	.080	2
3	1.35	3.36	5.29	.48	1.20	1.88	.0243	.0690	.352	.946	.0271	11.3	.991	.359	.080	3
4	.64	14.59	3.84	.24	5.56	1.46	.0482	.0690	.698	.916	.0451	-6.3	.992	.384	.080	4
5	.22	43.75	7.49	.08	16.65	2.85	.0521	.0690	.756	.901	.0541	3.8	.997	.382	.080	5
6	.09	18.13	9.34	.04	7.23	3.73	.0610	.0690	.884	.892	.0592	-2.9	1.004	.397	.080	6
7	20.65	32.50	8.88	**********		******	.0062	.0690	.090	.986	.0058	-5.4	.988	*****	.067	7
8	.37	12.89	8.79	.14	4.99	3.40	.0460	.0690	.666	.916	.0450	-2.1	1.035	.374	.080	8
9	.39	7.64	6.91	.16	3.12	2.82	.0420	.0690	.609	.923	.0410	-2.5	1.023	.399	.080	9
10	.49	3.67	6.40	.20	1.53	2.67	.0339	.0690	.491	.936	.0331	-2.3	1.013	.413	.080	10
11	.75	3.13	6.21	.40	1.67	3.32	.0251	.0690	.363	.952	.0242	-3.3	1.007	.531	.080	11
12	4.22	7.57	7.21	12.32	22.12	21.08	.0118	.0690	.171	.974	.0122	3.2	1.003	2.914	.080	12
13	15.37	24.61	8.65	**********		******	.0109	.0690	.158	.985	.0068	-37.5	.989	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- =	.401	GRAM/BHP-HR
BSCO ------- =	6.207	GRAM/BHP-HR
BSNOX ------ =	3.132	GRAM/BHP-HR
BSHC + BSNOX =	3.532	GRAM/BHP-HR
CORR. BSFC - =	.417	LBS/BHP-HR

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: CUMMINS 350
TEST 21 FUEL: EM-597-F
BAROMETER: 29.13
PROJECT: 03-7338-015
DATE: 8/3/84

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS LB-FT	POWER OBS BHP	FUEL FLOW LB/MIN	AIR FLOW LB/MIN	INTAKE HUMID GR/LB	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 650.	0.	.0	.078	7.32	75.	1.021	640.	411.	1.31	70.	98.	125.	36.	1
2	2	INTER / 1250.	20.	4.8	.132	14.47	75.	1.022	360.	165.	1.68	100.	76.	69.	70.	2
3	25	INTER / 1250.	270.	64.3	.410	15.22	75.	1.011	148.	189.	5.94	200.	29.	71.	125.	3
4	50	INTER / 1250.	540.	128.5	.758	18.69	72.	.996	124.	703.	8.84	460.	31.	329.	350.	4
5	75	INTER / 1250.	810.	192.8	1.215	22.81	72.	.991	64.	2205.	10.83	770.	21.	1335.	754.	5
6	100	INTER / 1250.	1080.	257.0	1.698	29.34	72.	.989	28.	2619.	12.19	410.	12.	1968.	497.	6
7		IDLE / 650.	0.	.0	.075	7.32	75.	1.021	664.	485.	1.31	80.	96.	141.	39.	7
8	100	RATED / 2100.	790.	315.9	2.042	45.10	75.	1.000	68.	1281.	9.58	595.	42.	1484.	1125.	8
9	75	RATED / 2100.	600.	239.9	1.565	37.68	69.	.990	62.	794.	8.84	410.	32.	767.	640.	9
10	50	RATED / 2100.	395.	157.9	1.182	31.19	69.	.991	76.	435.	7.67	255.	34.	367.	348.	10
11	25	RATED / 2100.	200.	80.0	.692	27.47	69.	.995	76.	201.	5.47	190.	27.	139.	214.	11
12	2	RATED / 2100.	15.	6.0	.280	24.67	69.	.999	296.	238.	2.49	115.	91.	144.	114.	12
13		IDLE / 650.	0.	.0	.075	7.22	72.	1.010	640.	460.	1.31	70.	93.	134.	34.	13

MODE	CALCULATED GRAMS/LB-FUEL HC	CO	NOX	CALCULATED GRAMS/BHP-HR HC	CO	NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	20.79	26.66	7.56	**********		******	.0108	.0690	.157	.986	.0067	-37.8	.992	*****	.067	1
2	9.60	8.75	8.84	15.93	14.51	14.67	.0092	.0690	.133	.982	.0082	-10.7	.996	1.667	.080	2
3	1.19	2.91	5.07	.45	1.11	1.94	.0272	.0690	.394	.946	.0278	2.0	.995	.385	.080	3
4	.68	7.24	7.70	.24	2.56	2.73	.0410	.0690	.594	.923	.0410	-.0	.998	.355	.080	4
5	.29	18.32	10.34	.11	6.93	3.91	.0538	.0690	.780	.907	.0504	-6.4	1.003	.377	.080	5
6	.11	19.32	4.88	.05	7.66	1.93	.0585	.0690	.848	.897	.0564	-3.5	1.011	.392	.080	6
7	21.43	31.25	8.59	**********		******	.0104	.0690	.150	.986	.0068	-34.6	.993	*****	.067	7
8	.35	12.11	9.18	.13	4.70	3.56	.0458	.0690	.663	.917	.0445	-2.8	1.040	.373	.080	8
9	.34	8.17	6.81	.13	3.20	2.67	.0419	.0690	.608	.923	.0410	-2.3	1.027	.381	.080	9
10	.48	5.18	4.90	.21	2.32	2.20	.0383	.0690	.555	.932	.0356	-6.9	1.015	.442	.080	10
11	.66	3.36	5.15	.34	1.74	2.67	.0254	.0690	.369	.950	.0256	.7	1.009	.514	.080	11
12	5.41	8.59	6.77	15.17	24.07	18.95	.0115	.0690	.166	.975	.0120	4.8	1.006	2.784	.080	12
13	20.72	29.74	7.46	**********		******	.0105	.0690	.152	.986	.0067	-35.7	.993	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- =	.440	GRAM/BHP-HR
BSCO ------- =	4.844	GRAM/BHP-HR
BSNOX ------ =	2.989	GRAM/BHP-HR
BSHC + BSNOX =	3.429	GRAM/BHP-HR
CORR. BSFC - =	.414	LBS/BHP-HR

13-MODE FEDERAL DIESEL EMISSION CYCLE 1979

ENGINE: CUMMINS NTC-350 BAROMETER: 29.13
TEST 22 FUEL: EM-597-F PROJECT: 03-7338-015 DATE: 8/7/84

MODE	POWER PCT	ENGINE SPEED COND / RPM	TORQUE OBS LB-FT	POWER OBS BHP	FUEL FLOW LB/MIN	AIR FLOW LB/MIN	INTAKE HUMID GR/LB	NOX CORR FACT	MEASURED HC PPM	MEASURED CO PPM	MEASURED CO2 PCT	MEASURED NOX PPM	CALCULATED GRAMS / HOUR HC	CALCULATED GRAMS / HOUR CO	CALCULATED GRAMS / HOUR NOX	MODE
1		IDLE / 650.	0.	.0	.085	9.71	75.	1.009	576.	286.	1.09	70.	115.	114.	46.	1
2	2	INTER / 1250.	25.	6.0	.125	19.60	75.	1.019	304.	141.	1.40	105.	73.	67.	83.	2
3	25	INTER / 1250.	285.	67.8	.365	20.54	77.	1.025	136.	117.	4.66	400.	30.	50.	287.	3
4	50	INTER / 1250.	580.	138.0	.842	22.81	77.	1.010	120.	299.	7.67	900.	38.	180.	892.	4
5	75	INTER / 1250.	860.	204.7	1.187	26.55	72.	.995	86.	1198.	9.47	1275.	32.	816.	1410.	5
6	100	INTER / 1250.	1150.	273.7	1.643	31.66	72.	.991	54.	3556.	10.95	1525.	24.	2847.	1974.	6
7		IDLE / 650.	0.	.0	.078	9.58	72.	.989	504.	286.	1.09	80.	93.	106.	48.	7
8	100	RATED / 2100.	830.	331.9	1.990	59.31	78.	1.019	74.	165.	7.04	1025.	61.	256.	2647.	8
9	75	RATED / 2100.	620.	247.9	1.460	51.53	78.	1.025	66.	117.	6.18	730.	45.	152.	1586.	9
10	50	RATED / 2100.	415.	165.9	1.105	44.62	73.	1.015	72.	94.	5.17	480.	44.	110.	934.	10
11	25	RATED / 2100.	207.	82.8	.660	37.68	77.	1.029	74.	106.	3.78	275.	36.	102.	442.	11
12	2	RATED / 2100.	15.	6.0	.308	33.04	77.	1.037	272.	165.	1.82	120.	125.	150.	185.	12
13		IDLE / 660.	0.	.0	.075	9.67	77.	1.024	488.	262.	1.05	70.	90.	96.	43.	13

MODE	CALCULATED GRAMS/LB-FUEL HC	CO	NOX	CALCULATED GRAMS/BHP-HR HC	CO	NOX	F/A DRY MEAS	F/A STOICH	"PHI"	WET HC CORR FACT	F/A CALC	F/A PCT MEAS	POWER CORR FACT	BSFC CORR LB/HP-HR	MODAL WEIGHT FACTOR	MODE
1	22.47	22.32	8.99	**********		******	.0088	.0690	.128	.988	.0056	-36.8	.997	*****	.067	1
2	9.70	8.96	11.10	12.23	11.30	13.99	.0064	.0690	.093	.984	.0069	6.4	.998	1.263	.080	2
3	1.38	2.29	13.12	.44	.74	4.23	.0180	.0690	.260	.955	.0219	21.9	.995	.324	.080	3
4	.76	3.56	17.66	.28	1.30	6.46	.0373	.0690	.541	.932	.0356	-4.6	.997	.367	.080	4
5	.44	11.46	19.80	.15	3.99	6.89	.0452	.0690	.654	.918	.0440	-2.6	.999	.348	.080	5
6	.24	28.88	20.02	.09	10.40	7.21	.0524	.0690	.760	.906	.0515	-1.7	1.004	.359	.080	6
7	19.79	22.46	10.14	**********		******	.0083	.0690	.120	.988	.0056	-32.7	1.000	*****	.067	7
8	.51	2.15	22.17	.18	.77	7.98	.0339	.0690	.492	.937	.0327	-3.7	1.037	.347	.080	8
9	.51	1.73	18.10	.18	.61	6.40	.0286	.0690	.415	.944	.0288	.5	1.025	.345	.080	9
10	.66	1.66	14.08	.26	.67	5.63	.0250	.0690	.363	.952	.0242	-3.3	1.016	.393	.080	10
11	.92	2.56	11.17	.44	1.23	5.34	.0177	.0690	.257	.964	.0178	.7	1.009	.474	.080	11
12	6.75	8.13	10.00	20.82	25.08	30.86	.0094	.0690	.137	.980	.0088	-6.4	1.005	3.069	.080	12
13	19.90	21.38	9.55	**********		******	.0078	.0690	.114	.988	.0053	-31.8	.995	*****	.067	13

CYCLE COMPOSITE USING 13-MODE WEIGHT FACTORS

BSHC ------- =	.496	GRAM/BHP-HR
BSCO ------- =	3.277	GRAM/BHP-HR
BSNOX ------ =	6.922	GRAM/BHP-HR
BSHC + BSNOX =	7.418	GRAM/BHP-HR
CORR. BSFC - =	.383	LBS/BHP-HR

TABLE A-14. FEDERAL SMOKE TEST TRACE EVALUATION

Engine Model: Cummins 350 Test No. C10-15 Date: 7-24-84

Engine S/N: _____ Run No. _____ Eval. By: R Jack

Accelerations

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	49.5	1	51.0	1	44.0
2	44.0	2	45.0	2	45.0
3	42.0	3	53.5	3	42.5
4	44.0	4	53.0	4	49.0
5	47.0	5	57.5	5	57.0
6	50.5	6	50.0	6	53.0
7	48.0	7	54.0	7	45.0
8	42.5	8	58.0	8	52.5
9	52.0	9	58.0	9	56.0
10	56.0	10	56.0	10	60.5
11	56.5	11	50.5	11	56.0
12	52.0	12	47.0	12	48.5
13	51.0	13	45.0	13	46.0
14	46.0	14	42.0	14	44.0
15	45.0	15	38.5	15	40.0
Total Smoke %	726.0		759.0		741.0

Factor (a) = $\frac{2226.0}{45}$ = 49.5 %

Lugging

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	80.0	1	77.5	1	81.0
2	80.0	2	78.0	2	81.0
3	81.0	3	79.0	3	80.0
4	80.0	4	80.0	4	84.0
5	84.5	5	80.0	5	79.0
Total Smoke %	405.5		394.5		405.0

Factor (b) = $\frac{1205.0}{15}$ = 80.3 %

Peak

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	84.5	1	80.0	1	84.0
2	81.0	2	80.0	2	81.0
3	80.0	3	79.0	3	81.0
Total Smoke %	245.5		239.0		246.0

Factor (c) = $\frac{730.5}{9}$ = 81.2 %

TABLE A-15. FEDERAL SMOKE TEST TRACE EVALUATION

Engine Model: Cummins 350 Test No. C10-16 Date: 7-30-84

Engine S/N: _____ Run No. _____ Eval. By: K. Jack

Accelerations

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	26.0	1	23.0	1	26.0
2	16.5	2	31.0	2	21.0
3	15.0	3	19.5	3	16.3
4	15.5	4	18.0	4	16.5
5	18.0	5	20.0	5	20.0
6	21.0	6	26.0	6	28.0
7	42.0	7	23.0	7	26.7
8	21.0	8	20.7	8	20.0
9	21.0	9	22.0	9	20.0
10	23.5	10	26.5	10	18.5
11	28.0	11	27.0	11	19.5
12	25.5	12	24.0	12	21.0
13	30.0	13	23.3	13	22.0
14	28.8	14	21.5	14	22.0
15	25.0	15	20.5	15	22.0
Total Smoke %	355.8		346.0		317.5

Factor (a) = $\frac{1021.3}{45}$ = 22.7 %

Lugging

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	12.5	1	12.3	1	11.5
2	12.0	2	12.0	2	11.5
3	12.3	3	12.0	3	12.0
4	13.0	4	12.5	4	12.0
5	12.5	5	12.3	5	15.5
Total Smoke %	62.3		61.1		62.5

Factor (b) = $\frac{185.9}{15}$ = 12.4 %

Peak

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	42.0	1	31.0	1	28.0
2	30.0	2	27.0	2	26.7
3	28.8	3	26.5	3	26.0
Total Smoke %	100.8		84.5		80.7

Factor (c) = $\frac{266.0}{9}$ = 29.6 %

TABLE A-16. FEDERAL SMOKE TEST TRACE EVALUATION

Engine Model: Cummins 350 Test No. C10-17 Date: 7/27/84

Engine S/N: _____ Run No. _____ Eval. By: A Jack

Accelerations

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	37.0	1	36.0	1	45.0
2	20.5	2	19.0	2	21.0
3	14.0	3	12.5	3	12.0
4	12.0	4	13.5	4	12.5
5	15.0	5	14.0	5	14.0
6	16.0	6	13.5	6	14.0
7	21.5	7	16.0	7	15.0
8	16.0	8	19.0	8	20.0
9	25.0	9	20.0	9	23.0
10	13.0	10	14.3	10	17.0
11	13.0	11	15.0	11	14.5
12	15.0	12	15.0	12	14.0
13	15.0	13	14.5	13	13.5
14	14.0	14	14.6	14	14.0
15	13.5	15	15.5	15	14.0
Total Smoke %	260.5		251.8		265.5

Factor (a) = $\frac{777.8}{45}$ = 17.3 %

Lugging

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	13.5	1	14.8	1	14.7
2	12.0	2	14.0	2	14.0
3	12.0	3	14.5	3	13.3
4	12.0	4	13.5	4	12.5
5	11.8	5	14.8	5	13.3
Total Smoke %	61.3		71.6		67.8

Factor (b) = $\frac{200.7}{15}$ = 13.4 %

Peak

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	37.0	1	36.0	1	45.0
2	25.0	2	20.0	2	23.0
3	21.5	3	19.0	3	21.0
Total Smoke %	83.5		75.0		89.0

Factor (c) = $\frac{247.5}{9}$ = 27.5 %

TABLE A-10. FEDERAL SMOKE TEST TRACE EVALUATION

AM

Engine Model: Cummins NTC-350 Test No. 20 Date: 8-3-84

Engine S/N: _____ Run No. _____ Eval. By: K. Juck

Accelerations

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	22.0	1	19.0	1	21.0
2	25.0	2	38.5	2	33.0
3	19.0	3	20.0	3	20.0
4	17.7	4	18.0	4	17.5
5	20.0	5	20.5	5	18.5
6	23.3	6	20.5	6	21.0
7	20.0	7	22.0	7	20.0
8	27.0	8	21.8	8	28.0
9	21.0	9	22.5	9	20.0
10	20.3	10	23.0	10	22.0
11	23.5	11	22.5	11	22.0
12	25.0	12	21.0	12	18.5
13	25.0	13	18.5	13	18.0
14	25.0	14	18.0	14	16.5
15	20.5	15	17.5	15	16.0
Total Smoke %	334.3		323.3		312.0

Factor (a) = $\frac{969.6}{45}$ = 21.6 %

Lugging

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	15.2	1	15.5	1	15.0
2	15.0	2	15.0	2	15.0
3	15.0	3	16.0	3	16.5
4	14.8	4	16.0	4	17.0
5	15.0	5	15.2	5	16.0
Total Smoke %	75.0		77.7		79.5

Factor (b) = $\frac{232.2}{15}$ = 15.5 %

Peak

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	27.0	1	38.5	1	33.0
2	25.0	2	23.0	2	28.0
3	25.0	3	22.5	3	22.0
Total Smoke %	77.0		84.0		83.0

Factor (c) = $\frac{244.0}{9}$ = 27.1 %

TABLE A-11. FEDERAL SMOKE TEST TRACE EVALUATION

PM

Engine Model: Cummins NTC-350 Test No. 21 Date: 8-3-84

Engine S/N: _____ Run No. _____ Eval. By: K Jack

Accelerations

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	24.0	1	39.0	1	39.0
2	33.0	2	25.0	2	20.0
3	21.0	3	15.0	3	15.0
4	23.0	4	19.5	4	18.5
5	29.5	5	19.5	5	17.5
6	31.0	6	30.0	6	33.0
7	22.3	7	37.0	7	25.0
8	22.0	8	14.0	8	16.5
9	26.0	9	17.0	9	18.0
10	24.0	10	18.0	10	17.5
11	23.0	11	19.5	11	19.0
12	22.0	12	20.0	12	18.5
13	22.0	13	19.3	13	18.3
14	23.0	14	16.8	14	17.5
15	22.5	15	17.0	15	17.5
Total Smoke %	367.3		320.6		311.3

Factor (a) = $\frac{999.2}{45}$ = 22.2 %

Lugging

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	10.5	1	10.0	1	8.8
2	10.5	2	9.8	2	9.0
3	11.3	3	10.0	3	10.5
4	11.5	4	9.8	4	10.0
5	12.0	5	9.6	5	10.0
Total Smoke %	55.8		49.4		48.3

Factor (b) = $\frac{153.5}{15}$ = 10.2 %

Peak

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	33.0	1	37.0	1	39.0
2	31.0	2	33.0	2	33.0
3	29.5	3	30.0	3	25.0
Total Smoke %	93.5		100.0		97.0

Factor (c) = $\frac{290.5}{9}$ = 32.3 %

TABLE A-12. FEDERAL SMOKE TEST TRACE EVALUATION

Engine Model: Cummins NTC-350 Test No. 22 Date: 8/6/84

Engine S/N: _____ Run No. _____ Eval. By: T. Jack

Accelerations

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	12.5	1	10.3	1	11.0
2	12.5	2	10.5	2	10.5
3	8.8	3	8.3	3	7.2
4	7.0	4	7.0	4	5.8
5	7.0	5	7.5	5	6.0
6	8.1	6	8.0	6	7.3
7	8.4	7	7.5	7	7.0
8	9.5	8	7.5	8	8.5
9	7.0	9	7.0	9	6.5
10	6.3	10	8.2	10	7.5
11	6.3	11	7.4	11	6.6
12	6.7	12	7.5	12	7.5
13	6.5	13	7.0	13	6.3
14	6.5	14	7.6	14	6.0
15	5.3	15	6.6	15	5.5
Total Smoke %	118.4		117.9		109.4

Factor (a) = $\frac{345.7}{45}$ = 7.7 %

Lugging

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	2.9	1	3.7	1	3.3
2	2.8	2	3.7	2	3.3
3	3.0	3	3.9	3	3.4
4	3.0	4	3.5	4	3.3
5	3.0	5	3.7	5	3.4
Total Smoke %	14.7		18.5		16.7

Factor (b) = $\frac{49.9}{15}$ = 3.3 %

Peak

First Sequence		Second Sequence		Third Sequence	
Interval No.	Smoke %	Interval No.	Smoke %	Interval No.	Smoke %
1	12.5	1	10.5	1	11.0
2	12.5	2	10.3	2	10.5
3	1.5	3	8.3	3	8.5
Total Smoke %	34.5		29.1		30.0

Factor (c) = $\frac{93.6}{9}$ = 10.4 %

APPENDIX B

EGR SYSTEM CONTROL VOLTAGE SCHEDULES

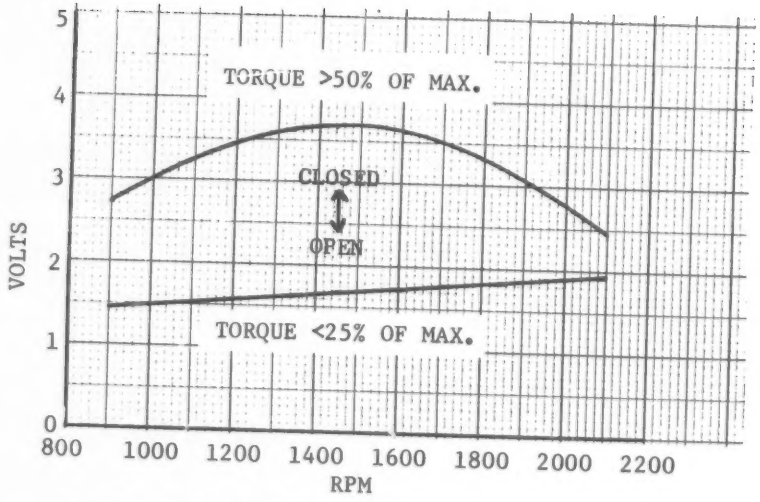

Figure B-1. EGR valve control voltages, Tests C10-8,-9

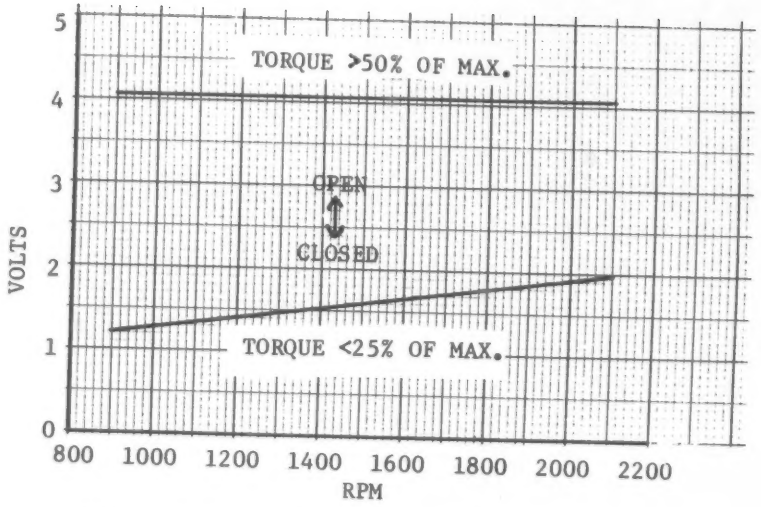

Figure B-2. Backpressure valve control voltage, Test C10-8

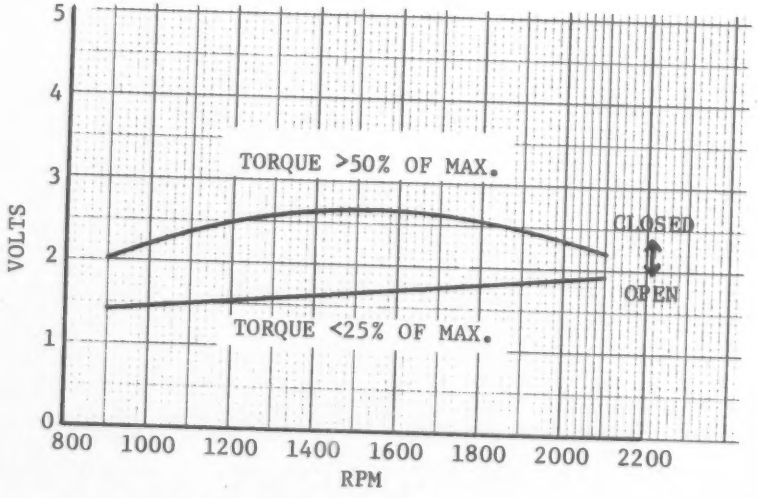

Figure B-3. EGR valve control voltages, Test C10-10

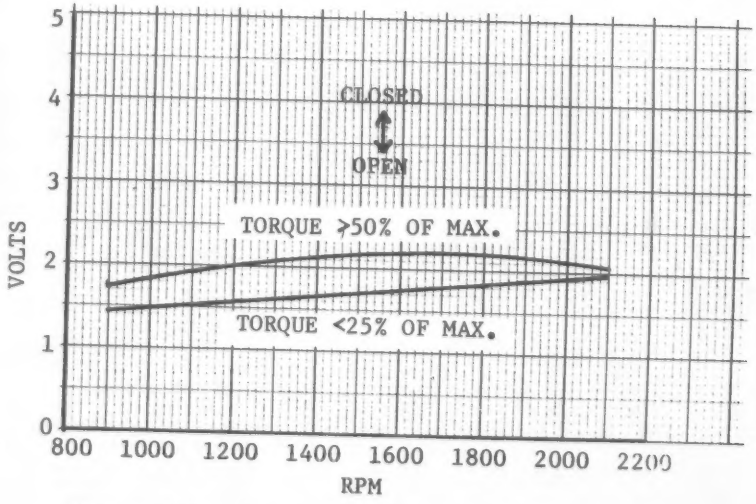

Figure B-4. EGR valve control voltages, Test C10-11

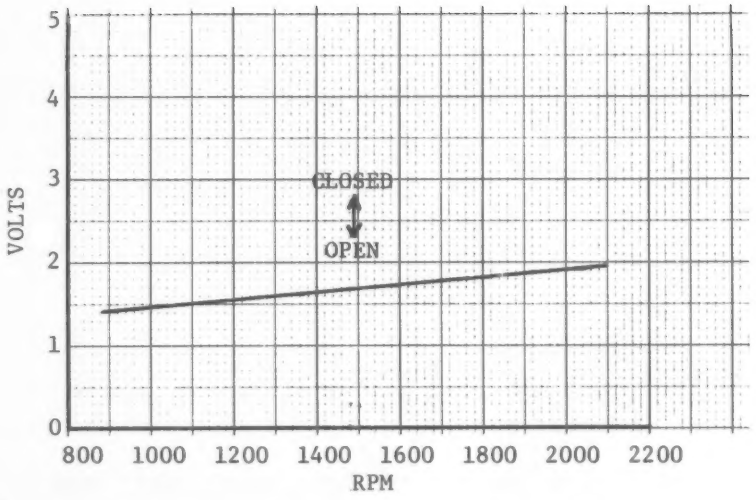

Figure B-5. EGR valve control voltages, Test C10-12

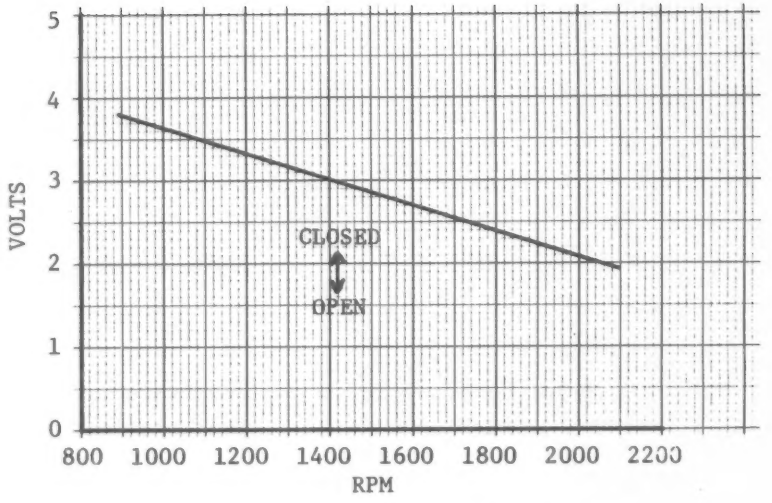

Figure B-6. EGR valve control voltages, Test C10-13

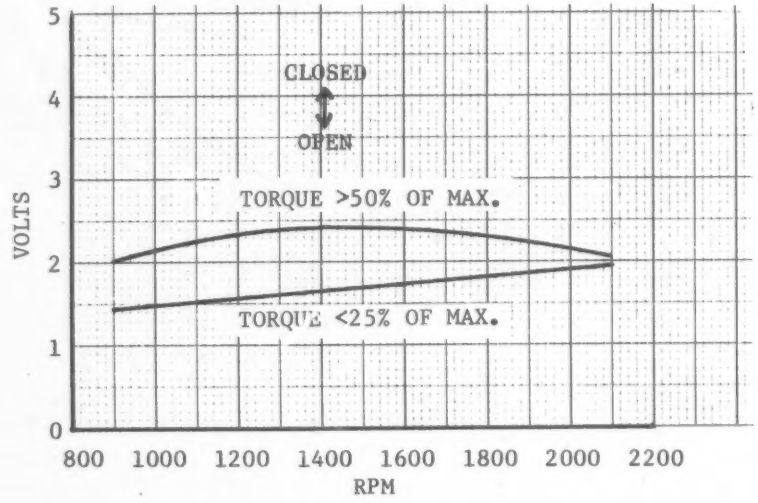

Figure B-7. EGR valve control voltages, Test C10-14

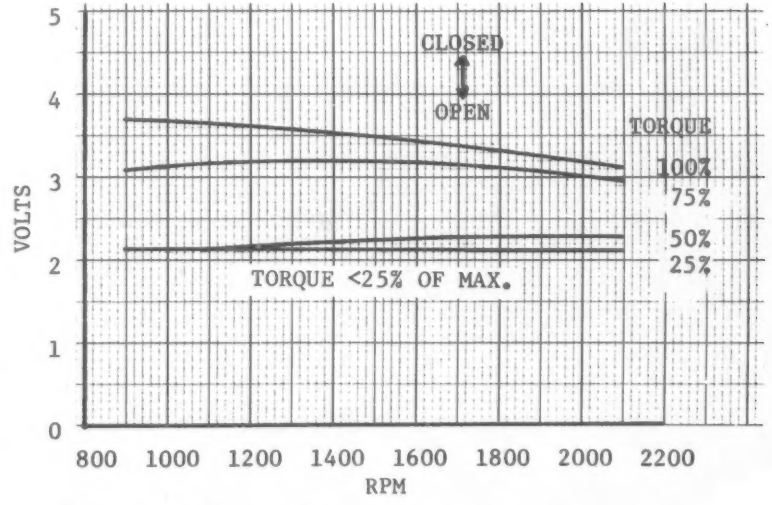

Figure B-8. EGR valve control voltages Tests C10-16,-18,-20

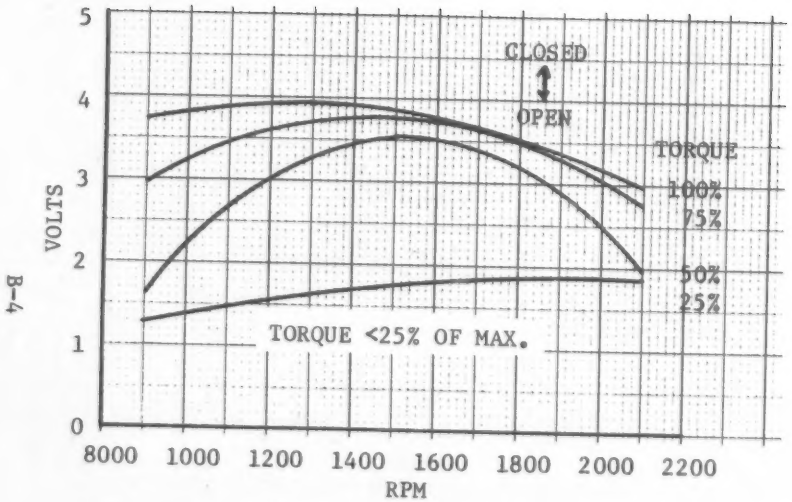

Figure B-9. EGR valve control voltages, Test C10-17

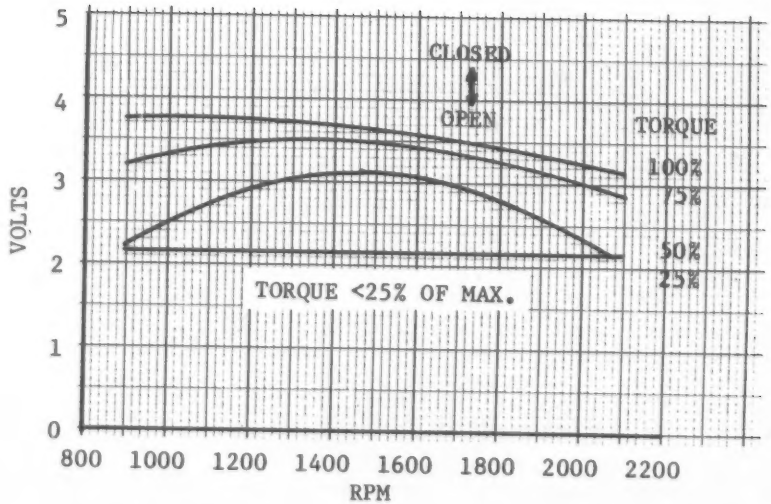

Figure B-10. EGR valve control voltages, Test C10-21